

**TxDOT Design-Build
Quality Assurance Program**

Implementation Guide



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B	Code of Federal Regulations 23 CFR 637B
C	FHWA Technical Advisory T 6120.3
D	Federal-Aid Policy Guide NS 23 CFR 637B
E	Monthly and Final Material Certification Letters
F	I2MS 3.0 Deployment Guide
G	Contract Language for Off-Site Inspection and Testing Services Provided by TxDOT
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1 Overview

This Design-Build (DB) Quality Assurance Program (QAP) Implementation Guide provides guidance for the finalization and implementation of [TxDOT's DB QAP](#) for DB Comprehensive Development Agreement (CDA) projects undertaken by the Texas Department of Transportation (TxDOT). This guide covers four primary topics:

1. Finalization of the QAP;
2. Approval of the Owner Verification and Testing and Inspection Plan (OVTIP) and the Construction Quality Management Plan (CQMP);
3. Implementation of the approved DB QAP during construction; and
4. Closing out the project.

The primary objectives of this guide are to:

1. Provide consistency and practical guidance in the DB QAP implementation processes on TxDOT DB CDA projects; and
2. Outline the processes for finalizing the DB QAP, approving the OVTIP and CQMP, implementing the approved DB QAP during construction, and closing out the project.

1.1 Background

TxDOT has charged the Construction Division, Materials and Pavements Section (CST/M&P) with the implementation and delivery of TxDOT's DB QAP program on DB CDA projects. CDAs are tools to acquire, design, construct, rehabilitate, extend, expand, improve, and potentially finance, operate, and maintain transportation facilities. CDA projects are often significant regional or statewide transportation projects with large capital outlays, numerous project partners and stakeholders, complex phasing and staging, and implementation over several years. CDA projects use public-private partnerships (P3s) and alternative means to expedite project delivery in which activities overlap and responsibilities and risk allocations are multifaceted.

Quality assurance on traditional TxDOT design-bid-build projects has long been addressed by TxDOT's traditional QAP, first approved by the Federal Highway Administration (FHWA) in June 2000 and most currently revised in June 2005. This traditional QAP encompassed all of TxDOT's traditional projects whereby TxDOT (or its agent) would perform all the acceptance sampling and testing. Since TxDOT performed the acceptance sampling and testing in accordance with the TxDOT Guide Schedule of Sampling and Testing (herein referred to as the Guide Schedule), there was no need for verification sampling and testing. On fast-paced CDA projects, however, TxDOT has chosen to transfer the responsibility for Guide Schedule acceptance sampling and testing to the Developer (a.k.a. the design-builder). Since the Developer's sampling and testing is used as part of the acceptance decision, the Code of Federal Regulations (CFR) requires verification of the Developer's sampling and testing results by TxDOT (or its agent).

The use of Developer test results as part of the acceptance decision should be carefully evaluated for each project because a significant TxDOT owner verification (OV) program is instrumental to the project's success.

1.2 FHWA Requirements

In the 1980s, Developers began to assume testing and inspection responsibilities associated with quality control (QC) for project-produced materials. This created a perception that the testing effort was being duplicated, since the Developer performed QC testing and the state transportation agency performed acceptance testing. A revision of FHWA's sampling and testing regulation titled "Quality Assurance Procedures for Construction" was published on June 29, 1995 as Title 23, Code of Federal Regulations, Part 637, (henceforth referred to as the CFR). This regulation permits the use of Developer test results in the acceptance decision, "provided that adequate checks and balances are in place to protect the public investment." The purpose of the CFR is, "to prescribe policies, procedures, and guidelines to ensure the quality of materials and construction in all federally-aided highway projects on the National Highway System." FHWA provided guidance and recommendations for the use and validation of Developer test results in the acceptance decision, recommended quality measures, and identified Developer/department risks in FHWA Technical Advisory T 6120.3, issued on August 9, 2004. FHWA later issued a non-regulatory supplement, NS 23 CFR 637B, on July 19, 2006 to provide additional guidance.

The three documents cited above are provided as Attachments B through D to this guide and are available at the following links:

1. 23 CFR 637B - http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr637_03.html;
2. TA T 6120.3 - <http://www.fhwa.dot.gov/construction/t61203.cfm>; and
3. NS 23 CFR 637 - <http://www.fhwa.dot.gov/legsregs/directives/fapq/0637bsup.htm>.

The following are key points from the CFR, technical advisory, and non-regulatory supplement as it pertains to the use of Developer test results in the acceptance decision.

1. Quality Assurance Program. Each State Highway Agency (SHA) must develop a quality assurance program that will assure materials and workmanship incorporated into each federally-aided highway construction project on the national highway system are in conformity with the requirements of the approved plans and specifications, including approved changes. The program must meet the criteria in 23 CFR 637.207 and be approved by FHWA. Each SHA's quality assurance program shall provide for an acceptance program and an independent assurance (IA) program.
2. Independent Assurance Program. Developer and owner verification sampling and testing are evaluated by an independent assurance (IA) program. Independent assurance samples and tests or other procedures performed by qualified sampling and testing personnel employed by the SHA or its designated agent are maintained underneath the provisions of this program.
3. Acceptance Program. Quality control (called quality acceptance in the TxDOT DB QAP) sampling and testing results may be used as part of the acceptance decision provided that:

The sampling and testing has been performed by qualified laboratories, using qualified sampling and testing personnel.

The quality of the material has been validated by verification of the testing and sampling. The verification sampling will be performed on samples taken independently of the quality acceptance samples.

An IA program will evaluate the quality control sampling and testing.

4. Verification Sampling and Testing. The verification sampling and testing are to be performed by qualified testing personnel employed by the SHA or its designated agent, excluding the Developer and vendor.
5. Dispute Resolution System. If the results from the quality acceptance (QA) sampling and testing are used in the acceptance program, the SHA must establish a dispute resolution system. The dispute resolution system will address the resolution of discrepancies occurring between the verification sampling and testing and the quality acceptance sampling and testing. The dispute resolution system may be administered entirely within the SHA.
6. Random Samples. All results used for QA, verification sampling, and testing must be obtained from random samples.

Below are some important definitions and general guidance related to the policy above.

1. Acceptance Program. All factors that comprise the SHA's determination of the quality of the product as specified in the contract requirements. These factors include verification sampling, testing, and inspection and may include results of QA sampling and testing.
2. IA Samples and Tests. Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. Test procedures used in the acceptance program that are performed in the SHA's central laboratory would not be covered by an IA program. IA samples can either be Proficiency Samples or Split Samples.
3. Proficiency Samples. Homogenous samples that are distributed and tested by two or more laboratories, usually conducted on an annual basis. The test results are compared to one another to assure that the laboratories are obtaining the same results. Evaluation methods are usually statistically based, whereby a relative rating is assigned.
4. Split Samples. Samples that are divided homogeneously from a single source and tested by two or more laboratories. The differences in test results are compared to an operational tolerance to verify that both laboratories are obtaining the same results. This evaluation method is usually selected to compare two individual technicians or when sampling methods are not conducive to proficiency sampling.
5. Qualified Laboratories. Laboratories that are capable as defined by appropriate programs established by each SHA. At minimum, the qualification program must include provisions for checking test equipment, and the laboratory must keep records of calibration checks.
6. Qualified Sampling and Testing Personnel. Personnel who are capable as defined by appropriate programs established by each SHA.
7. Quality Assurance. All planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.
8. Quality Control. All Developer/vendor operational techniques and activities performed or conducted to fulfill the contract requirements that are not a part of the acceptance program.
9. Random Sample. A sample drawn from a lot in which each increment in the lot has an equal probability of being chosen.
10. Vendor. A supplier of project-produced material that is not the Developer.
11. Verification Sampling and Testing. Sampling and testing performed to validate the quality of the product.

Information contained in FHWA Technical Advisory T 6120.3 (Attachment C) supersedes earlier FHWA direction and stands as the most current guidance on this subject matter. The advisory discusses the use of Developer tests results for acceptance, requirements for verification sampling and testing, and validation procedures on random-independent samples. In the discussion on validation procedures performed on independent samples, it recommends the use of the F-test and t-test because, “they have more power to detect actual differences.” More information on statistical procedures can be found in course material for National Highway Institute (NHI) Course No. 134042, other FHWA publications, or regular statistics textbooks or handbooks. A review of current state construction QA programs can be found in NCHRP Synthesis 346.

1.3 General Approach to Quality Assurance on CDA Projects

The DB QAP established by TxDOT ensures that materials and workmanship incorporated into the highway construction project are in reasonable conformance with the approved plans and specifications, including any approved changes. This program is developed based on 23 CFR 637 Part B (Attachment B) and FHWA Technical Advisory T 6120.3 (Attachment C). The program consists of a QC program, an acceptance program, and an IA program. The QAP allows for the use of Developer-performed QA test results as part of an acceptance decision if the QA results are validated by the OV testing results performed by TxDOT.

The purpose of this guide is to provide statewide consistency and a programmatic approach to Quality Assurance for DB projects where the Developer’s test results are used in the acceptance decision, regardless of how the project is funded. It clarifies federal requirements relating to QA and verification procedures related to OV. The content of this program is developed for projects with an optional 15-year maintenance agreement as part of the DB CDA with no Special Experimental Project 15 (SEP-15) exceptions with respect to QA. This document is to be included (or referenced) in the Request for Proposal (RFP), CDA, and other key preconstruction project documents and approvals by TxDOT and FHWA. Any modification to the DB QAP requires review and approval by TxDOT and FHWA 90 days prior to construction. Per the code of federal regulations, the DB QAP is the umbrella program that covers the acceptance program and the IA program.

The acceptance program encompasses sampling and testing results that may be used as part of the acceptance decision. This approach to performing the acceptance program is used on traditional TxDOT design-bid-build projects. This approach is also used when TxDOT performs the frontline acceptance testing, as further described in Section 3.3. When the Developer performs frontline acceptance testing as part of the acceptance decision, as per the frequency established in the Guide Schedule, TxDOT is required to perform OV to verify the testing performed by the Developer. This approach is shown in Figure 1.3-1. Figure 1.3-1 also shows the relationship between the QA and OV portions of the acceptance program in relation to other portions of the overall QAP. Developer QC efforts are shown off to the right of the figure with a dotted line because the Developer’s QC efforts may not be used in the acceptance decision. In addition, QC does not participate in the requirements of the IA Program.

To avoid the appearance of a conflict of interest, any qualified laboratory will perform only one of the following types of testing on the same project:

1. QC testing,
2. QA testing,

3. OV testing,
4. IA testing, or
5. Referee testing.

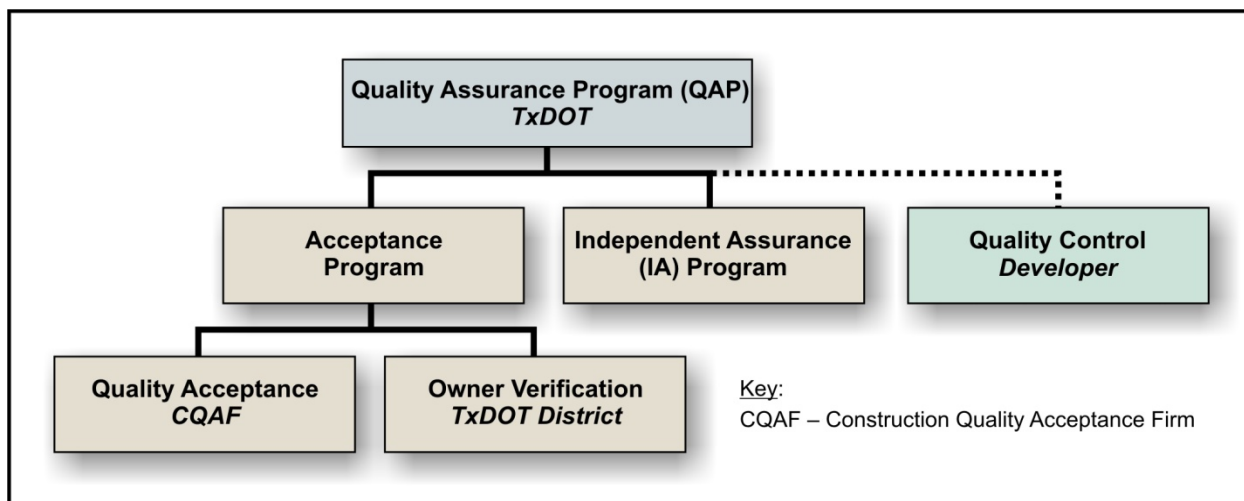


Figure 1.3-1: Components and Relationships in the QAP

1.4 DB QAP Implementation Process

This DB QAP Implementation Guide is structured on the following steps:

1. Finalize DB QAP,
2. Project Start-Up,
3. Project Operations, and
4. Project Close-Out.

The flowchart in Figure 1.4-1 reflects the relationship between the four steps. The first step is to revise the DB QAP based on the project-specific risk assessment workshop. The next step is for TxDOT to review and approve the Developer's CQMP, develop the project-specific OVTIP, and establish the IA program. Though these plans are established early on in the project, it is important to recognize that they are living documents that may need to be revised based on lessons learned during project operations. Finally, the project needs to be closed out.

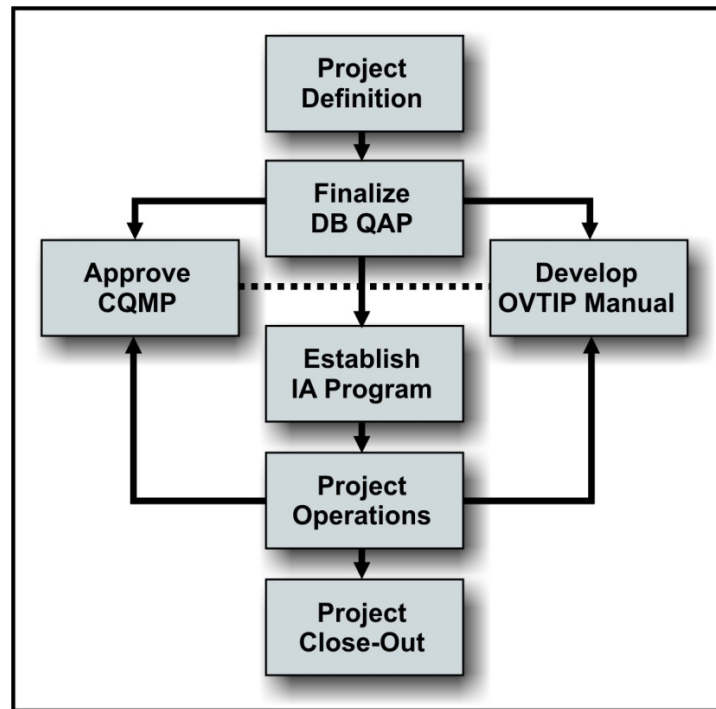


Figure 1.4-1: QAP Implementation Process

The QAP implementation process is designed to be completed following the approximate timeline shown in Figure 1.4-2. It is the CDA Project Manager’s responsibility to facilitate the process and ensure that it is started, executed, and successfully completed.

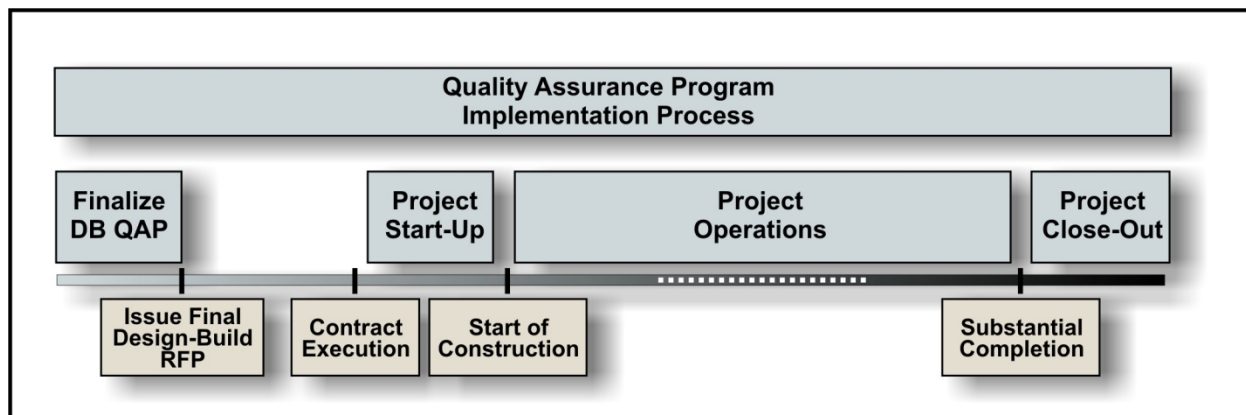


Figure 1.4-2: QAP Implementation Process Schedule

Project definition marks the start of the QAP implementation process. Figure 1.4-3 represents a hierarchical breakdown of the QAP implementation steps.

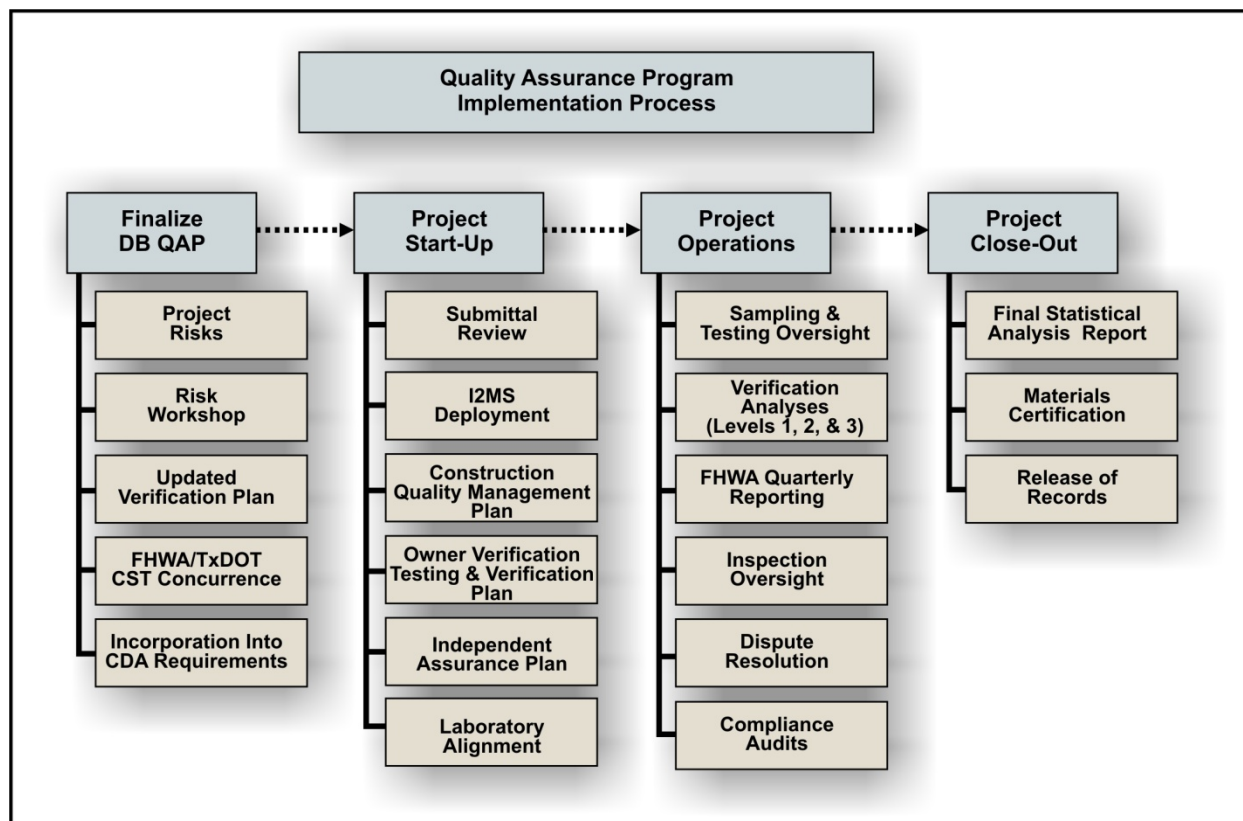


Figure 1.4-3: Hierarchical QAP Implementation Process and Sub-Processes

1. *Finalizing the QAP* is the first step of the QAP implementation process and takes a few weeks to complete once the risk workshop has been scheduled. Work involves identifying and reviewing material quality and contractual risk allocation, evaluating TxDOT's long-term risk, conducting the risk workshop with FHWA, and finalizing the verification approach and levels. By the end of this task, the project team should produce a project-specific QAP tailored to the risks associated with the specific project. The tailoring is specifically focused on Appendix D of the DB QAP (OVT Levels for Materials Testing Validation), though other modifications may be made with the approval of TxDOT's Construction Division (CST). This project-specific QAP should be included in the CDA procurement documents for the project to ensure that proposers are aware of the QA requirements.
2. *Project Start-Up* begins with the execution of the CDA and runs through the start of construction. The duration of this phase is dependent on each specific CDA project. At the end of this phase, the quality processes for administering the project should be completed, and regular operations can commence.
3. *Project Operations* begins after the start-up activities have been completed and runs through the end of the project. The duration of this phase is dependent on each specific CDA project.
4. *Project Close-Out* is the final step on the QAP implementation process and is the final documentation that the QA program has been successfully implemented.

1.5 Guide Organization

This DB QAP Implementation Guide is organized following the steps of the QAP implementation process. A brief synopsis of each section is provided below.

1. Section 1, *Overview*, offers background information and the fundamental concepts concerning the QAP implementation process and the content of this DB QAP Implementation Guide.
2. Section 2, *Finalize QAP*, discusses the specific information that must be gathered in the first step of the QAP implementation process through the finalization of the QAP and incorporation of those requirements into the CDA procurement documents.
3. Section 3, *Project Start-Up*, describes the development and approval of project quality documents, initial laboratory alignment, and Inspection and Materials Management System (I2MS) software deployment and training. It should be noted that I2MS deployment has a lead time, and efforts to deploy I2MS should be started immediately after the QAP is finalized.
4. Section 4, *Project Operations*, addresses the administration of the OV program and the statistical validation requirements.
5. Section 5, *Project Close-Out*, discusses the completion and compilation of final material quality documentation for the project and release of records.
6. Section 6, *Examples and Frequently Asked Questions*
7. Attachment A includes acronyms and abbreviations used in this guide. Attachments B through L provide information concerning the QAP implementation tools, including examples and illustrations of the tools.

1.6 Use of Guide

The intent of this DB QAP Implementation Guide is to provide TxDOT personnel and consultants with guidance for implementing a QA program on a DB CDA project. The material contained in the following sections describes “how-to” procedures with respect to implementing the QAP. This guide does not include specific procedures that would be included in an OVTIP manual; however, it does provide the necessary knowledge and information for users to create such a manual to meet the requirements for managing QA on CDA projects.

1.7 Section Summary

The information in this section provided a global overview on how to implement the TxDOT DB QAP on a project. Background information provided a historical perspective on the development of traditional and design-build QAPs. FHWA requirements, along with key definitions, were provided to clarify provisions that must be fulfilled by TxDOT, or its designee, when contractor test results are used as part of the acceptance decision. Flowcharts and timelines were provided to illustrate the common steps used in the implementation process from Project Definition to Project Close-Out.

The subsequent sections in this guide expand these topics with examples and general implementation recommendations. Throughout the guide, references will be made to supporting documents and additional literature. This information is provided as Attachments at the end of this guide for the reader’s reference. It should be noted that during project implementation, project staff are encouraged to use online versions of

the reference material, since periodic updates are made to the information and may not necessarily reflect the information contained in this guide.

2 Finalize DB QAP

TxDOT developed a programmatic QAP for DB projects with an optional 15-year Capital Maintenance Agreement in its efforts to standardize its practices. The current version of this document (July 25, 2011) can be found at the following link:

TxDOT DB QAP - ftp://ftp.dot.state.tx.us/pub/txdot-info/cst/qap_db.pdf

This programmatic DB QAP has been approved by FHWA for state-wide use. Within this document, there is a requirement to perform a project-specific risk-analysis to adjust OV parameters for the specific project in question.

2.1 Programmatic Owner Verification Testing (OVT) Approach

The development of TxDOT's OVT program using a three-tiered approach is based on very practical lessons learned from previous projects and national guidance provided by FHWA. The fundamental principle behind the three-tiered approach is to assign the appropriate level of resources to monitor and evaluate each analysis category based on TxDOT's residual risk after the Developer has completed construction and fulfilled its maintenance obligations. In general, the higher the residual risk for the performance of the material after the Developer's maintenance obligations expire, the higher the level of monitoring and verification. For example, concrete on a bridge structure is typically designed and constructed to perform over a service life significantly longer than 15 years (length of optional maintenance agreement on TxDOT DB projects,) so TxDOT has significant residual risk after the 15-year capital maintenance agreement has expired. Similarly, the stronger the relationship between the material property being tested and the material's performance, the higher the level of monitoring and verification required.

Appendix D of the TxDOT DB QAP contains the resulting programmatic DB verification approach. Within this section, there are start-up requirements, a table for the level of significance (I), a description of the levels of analysis, and a table stating the level of analysis for each "test method" within each "material or product." This programmatic approach was developed as a starting point from which project-specific teams can build on and modify based on project-specific conditions.

2.1.1 Start-Up Requirements

The start-up in Appendix D of the DB QAP specifically addresses the initial alignment of the QA and OV laboratories. This may be achieved through split-sample testing and will be described further in Section 3.5.

2.1.2 Description of Levels of Analysis

The first page of Appendix D of the TxDOT DB QAP contains a brief description of the verification approach. The three levels of verification are further described in Section 4.2 of this guide.

2.1.3 Level of Analysis Table

TxDOT's verification is divided into the tiers or approaches based on the material being tested and the test method.

Level 1 provides continuous analysis for those analysis categories that are strong indicators of performance. Examples include compressive strength for hydraulic cement concrete, percent soil compaction for embankment, and percent asphalt content for hot-mix asphalt concrete. The QA testing frequency is in compliance with the Guide Schedule, and the OV testing frequency should be a minimum of 10 percent of the QA testing frequency. F- and t- tests are performed on these material categories on a continuous basis with the addition of each OV test result. The p-values (from the F- and t- tests) are reported for each analysis and tracked over time. The p-value is a probability value ranging from 0 to 1 and is an indication of the probability that OV test data does not validate the QA test data. To implement this concept, the critical p-value is set equal to the level of significance (or alpha value) for each material category (e.g., alpha of 0.025 is equal to 2.5%). When the calculated p-value is above the established p-value, then statistical validation occurs. This new approach of tracking p-values over time enables TxDOT to efficiently monitor the validation status of each analysis category daily in “real time” and allows for more timely action to address non-validation.

Level 2 provides independent verification for those materials that are secondary indicators of performance. An example is the slump test for hydraulic cement concrete. The QA testing frequency is required to be in compliance with the Guide Schedule and the OV testing frequency should be a minimum of once per quarter.

Level 3 provides observation verification for those materials that only require very few QA tests for compliance with the Guide Schedule or tests on materials whose risk of failure does not affect the long-term performance of the facility past the contractual maintenance obligations. An example is the acid insoluble test (Tex-612-J) for fine aggregate in hydraulic cement for concrete pavements, which has a Guide Schedule defined frequency of once per project per source. Another example is the entrained air test (Tex-416-A) for non-structural (miscellaneous) concrete riprap where risk of failure does not affect the long-term performance of the facility past the contractual maintenance obligations. Under the Level 3 approach, OV does not perform tests but observes the QA test performance for equipment and procedural compliance with the test procedure. The frequency of this testing is a minimum of once per project per test method, or periodically as determined by TxDOT’s Materials Manager. For Level 3, the OV representative observing the QA technician performing the test enters his observation findings into I2MS for record keeping purposes.

Table 2.1-1 shows the first page of the default analysis category table contained in the TxDOT DB QAP. This table was developed using the required test methods contained in the Guide Schedule. A default level of analysis (1, 2, or 3) was assigned to each test for each analysis category (a combination of “material or product” and test method).

Table 2.1-1: Example Analysis Categories for Owner Verification

Levels for Analysis		Level 1	Level 2	Level 3	
EMBANKMENTS, SUBGRADES, BACKFILL, AND BASE COURSES					
MATERIAL OR PRODUCT		TEST FOR	TEST NO.	TxDOT RECOMMENDED	
EMBANKMENT (CUTS & FILLS)		Liquid Limit	Tex-104-E	2	
		Plasticity Index	Tex-106-E	1	
		Linear Shrinkage	Tex-107-E	2	
		Gradation	Tex-110-E	2	
		Moisture/Density	Tex-114-E	3	
		In-Place Density	Tex-115-E	1	
RETAINING WALL (NON-SELECT BACKFILL)		Liquid Limit	Tex-104-E	2	
		Plasticity Index	Tex-106-E	1	
		Linear Shrinkage	Tex-107-E	2	
		Gradation	Tex-110-E	2	
		Moisture/Density	Tex-114-E	3	
		In-Place Density	Tex-115-E	1	
RETAINING WALL (SELECT BACKFILL)		Gradation	Tex-110-E	2	
		Resistivity	Tex-129-E	2	
		pH	Tex-128-E	2	
		Soundness	Tex-411-A	3	
		In-Place Density	Tex-115-E	1	
		Liquid Limit	Tex-104-E	2	
UNTREATED BASE COURSES		Plasticity Index	Tex-106-E	1	
		Linear Shrinkage	Tex-107-E	2	
		Gradation	Tex-110-E	2	
		Moisture/Density	Tex-113-E	3	
		Wet Ball Mill	Tex-116-E	2	
		Triaxial	Tex-117-E	2	
		In-Place Density	Tex-115-E	1	
		Moisture Content	Tex-103-E	2	
		Thickness	Tex-140-E	1	
		Liquid Limit	Tex-104-E	2	
		Plasticity Index	Tex-106-E	1	
		Linear Shrinkage	Tex-107-E	2	
TREATED SUBGRADE AND BASE COURSES	New Base Material	Gradation	Tex-110-E	2	
		Moisture/Density	Tex-113-E	3	
		Wet Ball Mill	Tex-116-E	2	
		Triaxial	Tex-117-E	2	
		In-Place Density	Tex-115-E	1	
		Moisture Content	Tex-103-E	2	
		Thickness	Tex-140-E	1	
		Complete Mixture	Pulverizatin Gradation	Tex-101-E, Part III	2
			Moisture Content	Tex-103-E	2
	In-Place Density		Tex-115-E	1	
	Thickness		Tex-140-E	1	

2.1.4 Level of Significance for F- and t- Tests

The level of significance table in Appendix D of the DB QAP was developed to determine an appropriate level of analysis for the F- and t- tests used in the statistical validation process contained in Level 1. A greater level of significance means that the F- and t- tests are more discerning in the determination of non-validation. F- and t- tests performed at a level of significance of 0.025 (or 2.5 percent) have a greater chance of concluding that there is a statistical difference between the OV and QA results (i.e., non-validation) than a level of significance of 0.01 (or 1.0 percent).

Two factors were primarily used to empirically determine the default level of significance. The first factor is TxDOT's residual risk after the Developer is no longer responsible for the capital maintenance of the project. In general, the higher TxDOT's residual risk is, the higher the level of significance so that smaller statistical differences can be detected and investigated. At the same time, it is important to focus resources to investigate material significant differences. For example, it is possible that the percent compaction on embankment material is statistically different (i.e., non-validating) when the actual difference in the sample means of the OV and QA test result populations are less than 0.3 percent compaction. Therefore, while it is important to set the level of significance high enough to detect differences (non-validation), it is also important not to set it too high and detect materially insignificant differences.

Across the industry, there are two commonly used levels of significance: 0.01 and 0.025. TxDOT strived to implement a reasonable balance to address TxDOT's residual risk while trying to focus OV efforts on materially significant differences. Table 2.1-2 shows the default level of significance table from Appendix D of the DB QAP.

Table 2.1-2: Level of Significance F- and t- Tests

Material Category	Level of Significance (I)
Embankment, Subgrades, Backfill, and Base Courses	0.01
Asphalt Stabilized Base (Plant Mix)	0.01
Surface Treatments	0.01
Hydraulic Cement Concrete — Structural	0.025
Hydraulic Cement Concrete — Non-Structural	0.01
Hydraulic Cement Concrete Pavements	0.025
Asphalt Concrete Pavement (Items 341, 342, 344, and 346)	0.025
Asphalt Concrete Pavement (Items 330 and 334)	0.01
Asphalt Concrete Pavement (Item 340)	0.025

2.2 Development of Project-Specific Verification Approach

While there are default OVT levels set for each analysis category, each project has its own unique conditions that may warrant project-specific modifications to the default levels of analysis for some material categories. The risk workshop will evaluate the project-specific contractual framework and conditions (e.g., soil conditions, past performance of project elements in the area). For example, the DB QAP assumes an optional 15-year capital maintenance agreement. If a DB project does not have a capital maintenance agreement and maintenance of the project is the owner agency's responsibility upon final acceptance, the owner's residual risk is higher and the default levels may be lowered to increase the level of oversight and verification. TxDOT requires each project team to conduct a risk workshop with FHWA to evaluate any unique project-specific conditions. Based on the results of this workshop, the levels of analysis for each analysis category will be established for the project.

2.2.1 Sources of Information for Risk Workshop

For DB CDAs, TxDOT performs a risk workshop at the beginning of the procurement phase to evaluate all risks associated with the delivery method and project-specific conditions. The result of the workshop is the initial risk allocation for the CDA, which may evolve over time through the industry review process, one-on-one meetings with proposers, or changes in circumstances that necessitate revisions to arrive at the final contractual risk allocation. Information discussed and evaluated at the contractual risk workshop includes:

1. CDA contractual arrangement/obligations,
2. Geotechnical and pavement design reports,
3. Third-party memoranda of understanding (MOUs) and agreements,
4. Project-specific contractual risk allocation,

5. Project-specific technical provisions,
6. Preliminary design plans,
7. Subsurface utility engineering (SUE) reports,
8. National Environmental Policy Act (NEPA) documentation,
9. Right-of-way maps,
10. Drainage studies,
11. Maintenance of traffic (MOT) concepts, and
12. Traffic and revenue studies.

A subset of the above-listed information may be used for the materials-specific risk workshop to determine the appropriate project-specific verification approach. For example, the geotechnical information is likely to be very relevant, while the MOT concepts are not very relevant. Other relevant information may be the historical performance of construction materials in the area or specific technical provisions in the CDA that may make some materials more critical than would typically be considered.

2.2.2 Conducting the Material Quality Risk Workshop

As part of TxDOT's commitment to FHWA, a materials-specific risk workshop is conducted with TxDOT's project team, TxDOT CST, and FHWA to discuss the identified material quality risk and identify other potential material quality risks.

The project team should gather and evaluate the appropriate information in preparation for the materials quality risk workshop. This information should be distributed to workshop participants together with an agenda prior to the workshop so that participants can prepare. Below is a list of potential agenda topics for risk workshops:

1. Project Background,
2. Background to Default Levels of Analysis,
3. Project-Specific Areas of Risk and Impacts on TxDOT's Residual Risk,
4. Changes to the Default Levels of Analysis,
5. Changes to Level of Significance or Analysis Parameters for Continuous Analysis,
6. Additional Project-Specific Tests,
7. Unique Construction or Design Elements, and
8. Miscellaneous Items.

During the meeting, the project team will provide an overview of the project to impart a general understanding to participants new to the project, after which participants may proceed to discuss areas of concern specific to this project. Realize that the DB QAP was written for projects with an optional 15-year capital maintenance agreement. During the risk assessment workshops, the participants will need to discuss the impacts and risks associated with the optional capital maintenance agreement that may or may not be exercised on the project. Based on TxDOT's residual risk, the programmatic OVT approach may be modified to address project-specific risks.

It is desirable to get consensus between all participants during the workshop so that all parties can agree on the verification approach; however, there may be outstanding issues that arise from the workshop that cannot be addressed. Depending on how significant these issues are, the project team may proceed to finalize the proposed updated verification plan or choose to have additional communications (via e-mail, conference call, or meeting, as necessary) to reach a consensus.

2.3 Updated Verification Plan Submission and Approval

Once consensus has been reached with the project team, TxDOT CST, and FHWA, the updated verification plan should be prepared and submitted for approval by TxDOT CST and FHWA. Upon receiving approval, the updated verification approach can be incorporated into the DB QAP and included as contractual requirements in the DB QAP.

2.4 Incorporation of DB QAP into CDA Requirements

The updated OVT verification plan should be incorporated into the programmatic DB QAP as a substitute for Appendix D of the DB QAP. This will serve as the project-specific DB QAP for the project. This document contains various construction QC, QA, and OV requirements for the project.

The project-specific DB QAP should be incorporated into the CDA RFP and serve as contractual requirements for the Developer. With the DB QAP provided during the proposal phase, the Developer will have a clearer understanding of their contractual QC and QA obligations as well as their contractual obligations to support the OV program. In order for this to happen, the project-specific DB QAP has to be included in the RFP in time for proposers to review and evaluate the impact that these requirements might have on their proposal.

Initial discussions with TxDOT CST about the approximate timeframe in which I2MS will have to be deployed for the project are another important step to initiate at this time. This will allow TxDOT CST to prepare for this need and provide for timely deployment of the software and training of project staff. I2MS deployment and training is discussed in more detail in Section 3.2.

2.5 Section Summary

This section provided information on key concepts needed to finalize the DB QAP to meet project-specific conditions. These concepts include background information on the development of the three-tiered analysis approach as a tool that helps assign the appropriate level of resources to monitor and evaluate each material category. Level 1 provides continuous analysis for categories that are strong indicators of performance. Level 2 provides independent verification for materials that are secondary indicators of performance. Finally, Level 3 provides observation verification for those materials whose risk of failure does not affect the long-term performance of the facility past the contractual maintenance obligations.

Based on these key concepts, this section provided relevant explanations to finalize the material quality requirements through the use of a project-specific risk assessment workshop. This workshop provides project-level staff the opportunity to reassign default levels of analysis based on project-specific conditions.

At this point in the implementation process, project staff should:

1. Have read the programmatic DB QAP and understand key concepts related to:
 - a. QC, QA, OV, and IA project-level commitments, and
 - b. Differences between the various Levels of Analysis that will be used by the OV staff in the validation process.
2. Conduct a project-specific risk assessment workshop to potentially modify the default levels of analysis for each material category.
3. Submit updated verification plan changes to the DB QAP for TxDOT CST and FHWA approval.
4. Begin initial discussions with TxDOT CST/M&P on the approximate timeframe for the deployment of the I2MS software that will be used to store QA and OV testing data for statistical validation.

3 Project Start-Up

3.1 Submittal Review

A critical component to the successful delivery of a DB project is the submittal process. Examples of items normally reviewed by the owner include roadway, drainage, earthwork, pavement, and structural design packages as well as environmental, lighting, and traffic control plans. The responsibility of the reviewer is to provide prompt reviews while verifying that project elements are in compliance with CDA Documents and good industry practice. The various stages for submittals will vary from project to project, but may include Preliminary Design and Final Design (e.g., 30 percent, 60 percent), Early Start of Construction (ESC), and Release for Construction (RFC) plans. During each stage, prompt and thorough review by TxDOT allows the various elements of a project to move forward rapidly.

3.1.1 Developing a Review Plan

To allow for efficient reviews, TxDOT should develop a defined plan for review of various submittals with an appropriate amount of TxDOT staff allocated. Table 3.1-1 presents an outline of the various elements that can be included when developing a submittal review plan. This plan is applicable to design and construction reviews as well as to reviews of various submittals outlined within the DB QAP.

Table 3.1-1: Typical Elements of Review Plan

Review Plan	Description
Contact List	Listing of key project design and construction staff responsible for review
Design Exceptions	Protocol for review and approval of design exceptions by various government entities (TxDOT, FHWA, U.S. Army Corps of Engineers, Federal Aviation Administration, etc.)
Critical Path	Major milestones and required submittals listed as activities on project CPM schedule
Distribution List	Define responsible person and the number of copies for simultaneous distribution of submittals for review. Note that not all parties will need all summary and quantity sheets for review.
Numbering and File Naming Convention System	Tracking system for identifying submittals for review, revise/resubmit, and final. Establish file naming convention system.
Defined Review Times	Contractual time for submittal review (normally 10 working days)
Technical Working Group (TWG)	Define TWG members, establish meeting times, duration, record meeting minutes

3.1.2 Required Submittals in the DB QAP

The DB QAP includes commitments by QC, QA, OV, and IA team members to incorporate quality into the project. Table 3.1-2 provides key submittals that are reviewed by the TxDOT; however, other submittals may be required by the CDA Documents. The two major documents that will need to be developed and reviewed are the CQMP and the OVTIP. The development and implementation of these two documents are described in Sections 3.3 and 3.6.

Table 3.1-2: Summary of DB QAP Submittals

DB QAP Section	Document Name	Description	Reporting Timeframe
2.2.2	CQMP (QC portion)	QC commitments to incorporate quality into project elements	90-days prior to

			construction
2.2.3	Results of QC inspection and testing	Contains factual evidence that QC activities have been performed	Within 48 hours of completion
3.2.2	3-week look ahead schedule	Schedule of planned activities	Weekly
3.2.3	QA frequency compliance report	Tracking of QA testing to verify compliance with TxDOT Guide Schedule of Sampling and Testing	Weekly
3.2.3	OV frequency compliance report	Tracking of OV testing	Weekly
3.3.3	CQMP (QA portion)	QA commitments to inspect and test project elements	90-days prior to construction
3.3.3	QA mixture design approval	Includes approval of hot-mix asphalt, hydraulic cement concrete, soil-lime, and soil-cement mixture designs	As required
3.3.3	QA audits	Verify Developer compliance with approved CQMP	As required by CQMP
3.3.4	Results of QA inspection and testing	Contains QA inspection and testing activities	Within 48 hours of completion
3.4.2	OVTIP	Owner commitments to verify quality through oversight inspection and testing	90-days prior to construction
3.4.2	OV audits	Verify compliance with approved CQMP and OVTIP	As required by OVTIP
3.4.3	FHWA Quarterly Report	Developed by OV firm for TxDOT and FHWA approval	Each calendar quarter
3.4.3.1	OV statistical analyses	Developed by OV firm to monitor QA validation	Daily
3.4.3.3	Engineering Judgment Log	Materials that fail specification limits but are incorporated by Engineer	Within 24 hours of completion
3.4.3.4	Non-Conformance Log	Materials that fail specification limits but are incorporated by the Developer	Bi-weekly
3.4.3.5	Construction certification	CQAM certifies required activities and tests have been performed	Monthly

3.2 Deployment of TxDOT's I2MS Software

One of the most critical items that must be accomplished during the early stages of a DB project is to implement a data management and analysis system. In today's day and age, the use of electronic data is widely accepted and employed on highway engineering applications. For large fast-track projects, this becomes more critical because of the large volumes of data that need to be processed, stored, managed, and analyzed quickly and efficiently. TxDOT's I2MS, a secure web-based software program, was developed to manage and analyze QA and OV data. Version 3.0 of I2MS was updated to automate the new processes contained in the DB QAP. I2MS currently includes functionality for:

1. Workflow (data submission, review, and approval);
2. Data retrieval and searching;
3. Technician qualification (verify qualifications of technicians for tests being submitted into I2MS);
4. Data analysis; and
5. Verification analysis that includes a continuous analysis using F- and t- tests (Level 1), independent verification (Level 2), and observation verification (Level 3).

TxDOT's updated I2MS software provides an efficient and automated system to manage owner verification on TxDOT's alternate delivery program.

As discussed in Section 1.5, deployment of I2MS has a lead time, and efforts to deploy should be started immediately after the DB QAP is finalized. The oversight team should initiate discussions with TxDOT CST

early so that deployment efforts can begin. This will allow TxDOT CST to prepare for this need and provide for timely deployment of the software.

Some of the items that will need to be gathered are project-specific software and hardware for I2MS implementation. I2MS comes with standard functionality but requires some settings to be configured based on project-specific requirements. An example of this is setting the levels of analysis based on the results of the risk workshop.

3.2.1 I2MS Deployment Guide

Attachment F contains an I2MS Deployment Guide to understand the various components of the software that must be staged and deployed on a project. TxDOT CST is experienced in the procedural steps for deployment and should be contacted for further information and coordination.

3.2.2 Software Training

After deployment, software training for the various users on a project will need to be scheduled. The three training modules are for technical staff (two days), supervisors (two days), and project administrators (three days). A brief overview of this training is described below.

1. *Technical staff* training will cover the use of testing and inspection forms as appropriate for the work activities performed by an individual. In addition, basic website navigation, searching, and web form submittal functions will be covered in this training.
2. *Supervisor* training will emphasize knowledge of the workflow processes (review and approval of reports, maintenance of established controlled vocabulary lists [CVLs], etc.). Statistical analysis and data/trend analysis will also be covered in this training for laboratory supervisors.
3. *Project administrator* training will cover system fundamentals such as monitoring form submissions and data import results, user management and security documentation procedures, troubleshooting, and maintenance of the technician qualification module.

A Quick Reference Guide has been developed by TxDOT to provide the user with basic functionality of each of the features within I2MS. The Quick Reference Guide is available from TxDOT CST and is normally used as a reference document during training.

3.3 Construction Quality Management Plan (CQMP)

The CQMP consists of both process control (i.e., QC) and acceptance testing (i.e., QA) activities with respect to performance of the work and is required to be approved by TxDOT and FHWA 90 days prior to construction. The CQMP is considered a major submittal and can be very large (in excess of 400 pages), depending on the size and complexity of the project.

3.3.1 Purpose of the CQMP

The CQMP is created by the Developer and provides procedures that clearly describe how the Developer's staff will address various quality requirements. Each work activity (e.g., earthwork, drilled shafts) must be clearly described for both QC and QA operations with sufficient detail on how quality will be incorporated, how the activity will be constructed using hold points, and how acceptance of the product will be

administered. Specifically, each procedure should be written in a manner that can be easily evaluated for compliance. Most CQMPs are written from the perspective of a quality team approach in that each member of the construction staff, including subcontractors and suppliers, is responsible for incorporating quality into the project. Therefore, the Developer normally requires that each member of the Quality team receive indoctrination and training regarding the quality and technical requirements of the project.

3.3.2 Components of the CQMP

The CQMP is typically comprised of multiple volumes with various components in each volume. Table 3.3-1 provides an example format of a CQMP. In this example, Volume I describes the overarching quality program, the general requirements for execution, and the means and methods that the Developer will use to manage the inspection and testing services as well as the nonconformities that arise on the project. Volume II provides detailed procedures and the corresponding forms and checklists that must be completed by either the QC or QA staff.

3.3.3 Procedures, Forms, and Checklists

An important aspect to consider when reviewing the CQMP is to verify that procedures provide sufficient detail and that questions or checklists have been incorporated to document that the quality and technical requirements of the work elements are satisfied. For example, during a concrete pour, the QC representative should have a “pre-placement checklist” that describes the actions taken by the Developer or subcontractors prior to the actual placement of concrete into the forms. Items that might be provided on the checklist include survey measurements, placement grade, length, and location of reinforcing steel, along with clearance and cover requirements that need to be maintained. During the inspection process, the QA representative will verify that elevations of the drilled shaft are in accordance with the RFC plans and that the reinforcing steel has the correct length, diameter, lap length, etc. During the actual placement of concrete, the QA representative will test the concrete for acceptance and report results in the timeframe contractually agreed upon.

Table 3.3-1: Typical CQMP Components

Section	Description
Volume I	
Introduction	
Definitions	
Acronyms	
1.0	Responsibilities, Organization, and Staffing Plans
2.0	Construction Quality Management Plan
3.0	Contract/Subcontract Reviews
4.0	Design Control
5.0	Document and Data Control
6.0	Purchasing
7.0	Control of TxDOT- or Developer-Supplied Product
8.0	Product Identification and Traceability
9.0	Process Control
10.0	Inspection and Testing
11.0	Inspection, Measuring, and Testing Equipment
12.0	Inspection and Testing Status Reporting
13.0	Control of Nonconforming Product
14.0	Corrective and Preventive Action
15.0	Handling, Storage, Packaging, and Delivery
16.0	Quality Records
17.0	CQMP Audits
18.0	Education, Training, and Certification
19.0	Statistical Techniques
Volume II	
1.0	General QC/QA Procedures
2.0	General QC/QA Forms
3.0	QC Procedures
4.0	QC Forms
5.0	QA Procedures
6.0	QA Forms

Worksheets or forms are normally provided in the CQMP to document each of the steps mentioned above. Some of the procedures and forms that will be included in the CQMP have a requirement for each responsible person to sign the form. For example, after the QC representative conducts the pre-placement checklist, the QA representative signs the QC form as an acknowledgment that the process control activities have been performed.

Daily reports should also be required to document that inspections were performed, hold points were adhered to, and that work was in conformance with the requirements of the RFC documents. The following sections describe the commitments of both the QC and QA programs in more detail.

3.4 Quality Control Program

TxDOT requires the Developer to be responsible for establishing a systematic approach to define the processes, methods, procedures, and documentation for delivery of QC on the project. Section 2.2.2 of the DB QAP provides the minimum commitments that must clearly be addressed by the Developer's QC staff:

- A. A construction quality control organizational chart and staffing plan, which shall include the period of time that the QC staff members will be present on the site and the experience/knowledge/skill levels of QC staff.
- B. Procedures to ensure that the education, training, and Qualification of personnel performing CQMP activities are achieved and maintained and that all Work is performed in accordance with the approved designs, plans, and specifications.
- C. Procedures to ensure that Developer, Suppliers, and Subcontractors designate individuals on each crew responsible for performing daily field inspections of their own Work and for preparing a daily QC report to document the inspection performed. Report forms to be used by the responsible quality control personnel shall be included in the Developer's CQMP.
- D. Documents specifying that all activities undertaken by or on behalf of Developer affecting the quality of the Work shall be prescribed and accomplished by documented instructions, procedures, and appropriate drawings. Such instructions, procedures, and drawings shall include quantitative and qualitative criteria to be used to determine compliance.
- E. Procedures to ensure that critical elements of the Work are not started or continued without QA personnel on site for acceptance inspection and testing. Inspection or hold points shall be identified and communicated to the CQAF, CQCM, and TxDOT. Procedures to proceed beyond inspection or hold points shall be developed.
- F. Procedures for inspecting, checking, and documenting the Work. Inspection, examinations, and measurements shall be performed for each operation of the Work to assure quality.
- G. Procedures for identification and control of materials, equipment, and elements of the Work. These procedures shall ensure that identification of an item is maintained by appropriate means, either on the item or on records traceable to the item, as necessary, throughout fabrication, erection, installation, and use of the item.
- H. Procedures to ensure that materials, equipment, or elements of the Work that do not conform to requirements of the CDA Documents, the Governmental Approvals, applicable Law, or the Design Documents are not used or installed. These procedures shall include identification, documentation, segregation, disposition, and notification to TxDOT and, if appropriate, Governmental Entities and other affected third parties, as well as procedures for TxDOT to review Nonconforming Work.
- I. Procedures for processing a request for information (RFI) to resolve discrepancies and/or questions in the plans and specifications so that all changes are documented and approved by Developer's design engineers and TxDOT.

- J. Procedures to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the Work.
- K. A program for coordination of all CQAF inspections and testing with Governmental Entities and Utility Owners.
- L. A program to ensure performance of all testing required to demonstrate that all materials, equipment, and elements of the Work will perform satisfactorily for the purpose intended and meet the standards specified in the CDA Documents. It shall specify written test procedures that include provisions for ensuring that all prerequisites for the given test have been met and that adequate test instrumentation is available and used. The CQMP shall require test results be documented and evaluated by the CQCM to ensure that test requirements have been satisfied.
- M. Measures to ensure that tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly maintained, controlled, calibrated, certified, and adjusted at specified periods to maintain accuracy within industry standards.
- N. The preparation of all Portland cement concrete, soil-lime treatment, soil-cement treatment, and hot mix asphaltic concrete mix designs by personnel who hold the required certifications as specified in the CDA Documents. Additionally, the designs shall be reviewed and sealed by a Licensed Professional Engineer attesting that the design meets TxDOT requirements for the specified class or grade for which it was prepared.
- O. Sampling and testing of all materials during the production or manufacturing processes so that only materials meeting the specifications are supplied for ultimate incorporation into the Work.
- P. Procedures to control the handling, storage, shipping, cleaning, and preservation of materials and equipment to prevent damage or deterioration.
- Q. Procedures to ensure that conditions adverse to quality, such as failures, malfunctions, deficiencies, defective material and equipment, deviations, and other Nonconforming Work are promptly identified and corrected. The procedures shall ensure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported in writing to TxDOT and to appropriate levels of Developer's management to ensure corrective action is promptly taken.
- R. Measures to control the receipt and issuance of documents, such as instructions, procedures, training manuals, and drawings, including changes thereto, which prescribe activities affecting quality. These measures shall ensure that approved documents, including authorized changes thereto, are reviewed for adequacy and approved for release by authorized personnel of Developer and are distributed to and used at the location where the prescribed activity is performed. Changes to documents shall be reviewed and approved by the same organizations that performed the original review and approval unless TxDOT consents, in writing, to another responsible organization.
- S. Requirements and methods for controlling documents.
- T. Procedures for checking and verifying the accuracy and adequacy of construction stakes, lines, and grades established by the Developer.
- U. Procedures for ensuring that construction alignment and grades are in accordance with the requirements contained in the current TxDOT Survey Guide.

Detailed procedures and forms contained in the CQMP are used to describe and document compliance with these commitments and to aid the QC staff in carrying out their duties. During the implementation of the DB QAP, each of the QC commitments must be monitored for compliance. The remainder of Section 3.4 will focus on providing guidance on several key aspects of the QC portion of the CQMP.

3.4.1 QC Staffing

The Developer must staff an on-site Construction Quality Control Manager (CQCM) responsible for the QC aspect of the CQMP. One of the major lessons learned from recent DB projects is to have TxDOT co-locate with the CQCM. Co-locating with the Developer's staff provides for better communication, timely coordination of activities, and quicker dispute resolutions. If co-location is not an option on your project, it is critical to establish a clear line of communication with members of the QC staff.

It is also important to realize that the DB QAP requires that the CQCM not be involved with either the scheduling or production activities. This allows the CQCM to focus on the implementation of the procedures and methods contained in the CQMP without consideration for impacts to production. The DB QAP also requires that all subcontractors' construction workforce are considered members of the QC staff. This promotes a unified approach to process control and an environment of quality.

The QC staff does not necessarily need to be qualified in construction inspection or certified in specific test methods, thus, these employees do not fall under the purview of the IA program; however, they should be knowledgeable in construction and testing methods and procedures.

3.4.2 Quality Control Activities

Although the QC results are not used in the acceptance program, the QC requirements stipulated in the DB QAP provide commitments by the Developer that quality will be incorporated into the project prior to requesting acceptance inspection and testing. During the course of a project, there will be times when material production appears to be inconsistent from load to load or from placement to placement. These inconsistencies can and should be identified by QC personnel, with appropriate corrective actions taken.

Since a Quality team approach is normally utilized by the Developer, the inspection of various work elements is often performed adequately by QC foremen and superintendents. Most Developers understand the means and methods necessary to properly construct an item of work. They will purchase materials and hire skilled craftsmen to properly construct an element of work. From the Developer's point of view, a balanced approach must be considered between speed of production and the risk of a product not being accepted. It is an exercise in risk management. The DB QAP indicates that when repeated QC shortfalls are identified by the CQAF, investigations of the QC program are required with corrective actions recommended to bring materials into a uniform and consistent production environment.

3.4.3 QC Documentation

Section 2.2.3 of the DB QAP requires documentation for QC activities. QC documentation consists of quality records of construction workmanship and materials quality records. These records should include factual evidence that the required inspections or tests have been performed. Examples of factual evidence include fresh concrete properties and updated control charts for asphalt content. This evidence can be submitted by suppliers or subcontractors, since a Quality team approach is normally utilized by the Developer. As part of QC documentation, proposed remedial actions and corrective actions taken should

be available for TxDOT review. This evidence can be verified through audits by either the QA or OV staff or through the review of QC Daily Work Reports by TxDOT.

Documentation should cover both conforming and defective or deficient features. The format of the documentation should be furnished to TxDOT as stipulated in the approved CQMP. Lastly, documentation should be updated by the agreed upon timeframe in the CDA Documents and the approved CQMP following the inspection or test, and readily available for review or audit.

3.5 Quality Acceptance Program

When reviewing the CQMP submittal, consider that the DB QAP requires the Developer to establish a systematic approach to define the processes, methods, procedures, and documentation for delivery of QA on the project. There are two types of acceptance on a DB project.

1. The first type of acceptance is TxDOT-performed acceptance where frontline acceptance testing and inspection are performed by TxDOT. In this scenario, only TxDOT's testing and inspection results are used in the acceptance decision.
2. The second type of acceptance is Developer-performed acceptance (i.e., QA) where frontline acceptance testing and inspection are performed by the Developer's CQAF. Under Developer-performed acceptance, OV and QA together are the basis for the acceptance decision.

It is important to understand that Developer-performed QA results may be used for acceptance only when they are validated by the OV results. QA is performed by the Developer, and OV is performed by TxDOT. If validation does not occur, OV results may potentially serve as the primary basis for acceptance. Therefore, it is imperative that material quality issues be resolved in a timely manner. See Section 4.5 for further discussions on this topic.

3.5.1 TxDOT-Performed Acceptance

As previously discussed, the DB QAP indicates that there are two types of acceptance on DB projects. The first type of acceptance is a TxDOT-performed acceptance where frontline acceptance testing and inspection are performed by TxDOT with the results used as part of the acceptance decision.

3.5.1.1 Quality Monitoring Program

The Quality Monitoring (QM) program and the associated Material Producer List (MPL) is one way for TxDOT to manage quality acceptance of materials. An example of TxDOT-performed acceptance is the aggregate materials listed on the Aggregate Quality Monitoring Program (AQMP). The QM program generally requires the supplier to have a QC program in routine use to monitor their production and verify that materials meet specification requirements. TxDOT will perform periodic inspection or testing to verify the supplier's QC program and continued adequacy of the subject material. Manufacturers adhering to the requirements of a QM program are listed in the MPL maintained on TxDOT's website.

If material quality is suspect or damage is visible from shipping, the CQAF has the right and responsibility to: (1) sample, test, and reject any materials that do not meet specification requirements; and (2) realize that additional testing by the QA staff above and beyond the testing that was performed under TxDOT-performed acceptance as part of the Guide Schedule. An example includes the aggregates used for surface treatments. Testing is not required for Los Angeles abrasion, magnesium soundness, and surface

aggregate classification when the aggregate source is listed on the Bituminous Rated Source Quality Catalog (BRSQC); however, project-level testing is still required for gradation, deleterious material, and decantation for normal weight aggregate. These required tests should be performed by the QA staff for acceptance and validated by the OV staff.

3.5.1.2 TxDOT Off-Site Inspection and Testing Services

Just like materials/products installed on the project, products fabricated off-site require inspection and testing. For DB projects, the Developer may choose to provide the inspection services or utilize the services provided by TxDOT. Should the Developer choose to utilize TxDOT to perform off-site inspection, an amendment to the contract must be executed between TxDOT and the Developer to show:

- TxDOT will be providing inspection services,
- language to hold TxDOT harmless,
- assurances that any maintenance agreements are not voided by this arrangement, and
- the mechanism for payment of services.

An example of such an amendment is shown in Figure 3.5-1, below:

RE: FCA Amendment No. 5: Amendment to FCA Article ? and addition of Exhibit XX**Dear Mr. L:**

This letter is being delivered to you in order to amend the Facility Concession Agreement for the SH 123 (FCA) dated May 21, 2010, between the Texas Department of Transportation (TxDOT) and SH 123 Concession Company, LLC (Developer). Initially capitalized terms not otherwise defined in this letter have the meanings given those terms in the FCA.

For good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, TxDOT and the Developer agree as follows:

1. The following new Section XX is inserted into the FCA:
Without in any way diminishing Developer's responsibility for quality assurance and quality control for the Facility and Work, TxDOT may participate in Developer's quality assurance and quality control process by performing certain material inspection and testing services pursuant to the terms of and as more particularly described in Exhibit XX. Developer acknowledges and agrees that TxDOT will not be responsible or bear any liability for any damages, increased costs, revenue losses, delays, or other impacts arising as a result of the services performed by TxDOT pursuant to Exhibit XX, including those arising from failure of or defect in any material or product inspected or tested, regardless of when such failure or defect may occur or be discovered. .
2. A new Exhibit XX is added to the FCA in the form attached hereto.
3. As hereby amended the FCA is in full force and effect.

If the foregoing correctly reflects your understanding of our mutual agreement, please so indicate by signing this letter in the place indicated below and returning four signed originals to TxDOT.

This letter may be signed in two or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

Sincerely,

Travis Austin Houston, P.E.

Innovative Project Development

cc:

Attached:

EXHIBIT XX - TERMS OF TxDOT MATERIAL INSPECTION AND TESTING SERVICES.

ACCEPTED AND AGREED TO

THIS _____ DAY OF APRIL, 2010

SH 123 CONCESSION COMPANY, LLC

By: _____

Name: Dallas Lubbock

Title: Chief Executive Office

Figure 3.5-1: Typical Language to Allow for TxDOT Off-Site Inspection Services

Examples of attachments for this Amendment are shown in Attachment G.

TxDOT off-site inspection and testing services for off-site fabricated items provides significant benefit for project efficiency and quality assurance. TxDOT currently maintains multiple Field Area Office locations throughout Texas with qualified, certified personnel. Examples of products inspected include concrete bridge deck panels, prestressed concrete beams, structural steel girders, lighting and signage structures, and many other highway products.

Attachment G includes an example of typical amendment language/guidance to be used by the Developer when utilizing TxDOT's off-site inspection services. During construction, the Developer will need to issue a

Work Request Letter to TxDOT identifying elements of work that will require TxDOT off-site fabrication and inspection. Key aspects of this guidance are summarized in Table 3.5-1.

Table 3.5-1: Documentation for Requesting TxDOT Off-Site Inspection Services

Item	Key Aspect
Form SMRI-1	<ul style="list-style-type: none"> • Project specific; • Provides all items requesting inspection; • Can modify form to fit project-specific needs; • List fabricator; • Submit form well in advance of requested inspection; and • Form does not replace Work Request Letter.
Work Request	<ul style="list-style-type: none"> • Sent as early as possible in the process; • Uniquely numbered in sequential order; • Describes the item and estimated quantity; • Each request is fabricator specific; • Indicate anticipated inspection date; • Provide point-of-contact; and • Must include attachments (shop drawings, specs, general notes, etc.)

3.5.2 Developer-Performed Acceptance

The second type of acceptance is Developer-performed acceptance by the Developer's CQAF. Under Developer-performed acceptance, the OV and QA testing results are used together to form the basis for the acceptance decision. As previously discussed, QA is performed by the Developer, and OV is performed by TxDOT or its designee. The CFR states that Developer-performed QA results may be used for acceptance when they are validated by OV results. Section 4.2 provides more detail on analysis procedures used in the validation process; however for brevity and clarity here, there are three levels of analysis. When the OV results verify the QA results, the QA results may be used as part of the acceptance decision. When the OV results do not verify the QA results, the OV and QA teams begin the task of investigating the cause(s). The general recommendations for non-validation investigations will be further explained in Section 4.4.

As a reminder, when TxDOT's representative performs sampling and testing directly for acceptance, validation is not required.

Section 3.3.3 of the DB QAP provides the minimum commitments, listed as A through Q below, which must be clearly addressed in the CQMP:

- A. Methods and procedures that clearly define the authority and responsibility for the administration of Developer's CQMP.
- B. Procedures for inspecting, checking, and documenting the Work for acceptance. Inspection, examinations, and measurements shall be performed for each operation of the Work to assure quality.

- C. Procedures to ensure that the education, training, and certification of personnel performing CQMP activities are achieved and maintained and that all Work is performed in accordance with the approved designs, plans, and specifications.
- D. Procedures for documenting and tracking the disposition of any identified noncompliance with the plans and specifications. These procedures shall include a clearly defined process for communicating identified non-compliances to TxDOT and the Developer.
- E. Measures to ensure that purchased materials, equipment, and services conform to the CDA Documents, the Governmental Approvals, applicable Laws, Rules, and the Design Documents. These measures shall include provisions for source evaluation and selection, objective evidence of quality furnished by Subcontractors and Suppliers, inspection at the manufacture or vendor source, and examination of products upon delivery.
- F. Measures to ensure that tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly maintained, controlled, calibrated, certified, and adjusted at specified periods to maintain accuracy within industry standards.
- G. A comprehensive system of planned and periodic audits of Developer's CQMP to determine adherence to and the effectiveness of the CQMP. CQAF personnel shall perform the audits in accordance with the written procedures or checklists. Audit results shall be documented, reviewed, transmitted to TxDOT, and acted upon by Developer. Follow-up action, including re-audit of deficient areas following corrective action, shall be taken where indicated.
- H. The requirements and methods for controlling documents. Developer's document control system shall be compatible with TxDOT's.
- I. Inspection of all Work to verify and document that the Work has been constructed in conformance with the released-for-construction plans, specifications, and approved working and shop drawings.
- J. Procedures on how quality acceptance material sampling and testing will be performed, including the process for generating random test locations, tracking material samples, processing material samples, review and approval of test records, tracking compliance with material testing frequency.
- K. Procedures for addressing failed tests. For a failed random independent test, a fixed test at the original failing test location and a new random independent test at a new location in the same lot are required. For a failed fixed test, a new fixed test is required at the original failing test location.
- L. Procedures for reviewing QA test results for compliance with mutually agreed-upon processes and naming conventions to ensure data integrity for accurate statistical analyses.
- M. Procedures for auditing of QC and QA records, documentation, procedures, and processes to verify compliance with the CDA Documents and approved CQMP.
- N. Procedures for the review and approval of all Portland cement concrete, soil-lime treatment, soil-cement treatment, and hot mix asphaltic concrete mix designs by a Licensed Professional Engineer. The CQAF shall also verify trial batches.
- O. Procedures for ensuring quality acceptance testing shall be performed at the frequency stipulated in the Guide Schedule.
- P. Procedures for ensuring quality acceptance staff shall provide oversight and perform audits of the quality control inspection and material sampling/testing operation.

- Q. Procedures for ensuring that pre-approved materials used on the project maintain their approved status on the AQMP. Materials that do not maintain AQMP approval shall be sampled and tested on a project-level basis.

Detailed procedures, checklists, and forms contained in the CQMP are used to describe these commitments and to aid the QA staff in carrying out their duties. During the implementation of the DB QAP, each of the QA commitments must be monitored for compliance. The remainder of Section 3.5.2 will focus on providing guidance on several key aspects of the QA program.

3.5.2.1 QA Staffing

The Developer must staff an on-site Construction Quality Acceptance Manager (CQAM) who is Licensed Professional Engineer in the State of Texas and is responsible for the QA aspect of the CQMP. It is important to realize that the CQAM reports jointly to Developer's management team and TxDOT. Similar to the requirements of the CQCM, the CQAM should not report to any person or party directly responsible for design or construction production. In the simplest of terms, the CQAM is equivalent to a TxDOT Area Engineer and acts independently from the Developer on acceptance decisions of construction inspection and materials sampling and testing. This does not preclude TxDOT in the acceptance decision. The role of the "Engineer" and the authority granted by TxDOT is described in Section 3.5.2.2.

Unlike the QC staff requirements, the QA staff is required to be qualified in the applicable inspection methods and certified in material sampling and testing procedures. When reviewing the QA portion of the CQMP, TxDOT should review the qualifications of the QA staff to verify that the appropriate level of experience in highway inspection exists and that material testing technicians have certifications by the appropriate certifying agency. The training and experience of the QA staff should be commensurate with the scope, complexity, and nature of the activity to be inspected and tested. Qualifications should include appropriate TxDOT certification for testing and inspection, as well as appropriate nationally-recognized certifications applicable to inspection or testing activities as required by TxDOT. The CQAF testing personnel must be qualified under the IA program as described in Section 3.7.

The size of the QA staff should reflect the volume of quality acceptance activities necessary for the work in progress and should be maintained in accordance with the approved CQMP. Like most DB projects, firms will "ramp-up" their staff as the project progresses. Using the 3-week look ahead schedule provided by the Developer as guidance, TxDOT will verify that the Developer's work is being monitored and accepted in the field in a manner consistent with the CDA Documents and the CQMP procedures. The goal is to provide sufficient QA staff for inspection and testing to enable the Developer to achieve the deadlines for substantial completion and final acceptance in addition to satisfying the concerns of the TxDOT for incorporating quality into the project.

3.5.2.2 Engineering Authority

TxDOT's *Standard Specifications for Construction and Maintenance of Highways, Street, and Bridges* is written in active voice, imperative mood in the attempt to provide clear and concise specifications without ambiguities. This style of writing essentially translates into a condition whereby the audience is the Developer. In other words, when the Engineer reads the Standard Specifications, he/she is speaking to the Developer. For example, "furnish backfill meeting the requirements of Item 132 of the type specified in the plans." Who provides the backfill? The answer is the Developer. If the Engineer needs to perform a task, it is specifically stated in the text (e.g., the Engineer will test for compliance).

Section 3.3.1 of the DB QAP states:

The CQAM shall review, approve, authorize, examine, interpret, and confirm any methods or procedures requiring the “Engineers’ review, approval, authorization, examination, interpretation, confirmation, etc.” which are contained in the TxDOT Standard Specifications.

The language provided above in quotation is a reference taken from the opening paragraphs in the Standard Specifications, Item 5, “Control of Work.” When applying the spec book on a DB project, a question that always arises is, “Who is the Engineer in the spec book?” For the most part, Section 3.3.1 cited above provides the answer that it is the CQAM; however, this decision depends on how much engineering authority has been granted by TxDOT to the CQAM. TxDOT may wish to judiciously grant engineering authority to the CQAM with the option of removing certain authority if the CQAM applies it in such a way that impacts TxDOT’s residual risk.

3.5.2.3 Quality Acceptance Activities by CQAF

The Developer’s QA portion of the CQMP shall include the internal procedures used by the Developer’s CQAF to ensure that each element of work is inspected and tested to verify compliance with the released-for-construction plans, approved shop drawings, working drawings, and specifications. The DB QAP indicates that the Developer’s QA program should be separate from the Developer’s QC program.

The CQAM is equivalent to TxDOT’s Area Engineer and is ultimately responsible for the inspection and testing on a project. The CQAM is responsible for direct inspection and sampling and testing of materials for acceptance. The CQAF must have qualified personnel at each work location on the project ready to make decisions on the overall quality of material and workmanship to verify compliance with the project specifications and RFC drawings.

The CQMP must describe CQAF personnel duties and provide a clear understanding of all roles and responsibilities. It is suggested that meetings be held during the start-up operations for each element of work to clarify roles, responsibilities, and authority between the CQAM and the TxDOT Oversight Team. It is important that key understanding from these meeting be disseminated to the field staff of each party to ease implementation efforts.

When materials or workmanship fail to meet specifications, the CQAM is responsible for initiating clarification through such tools as the Construction Deficiency Report (CDR), Request for Information (RFI), Field Clarification Request (FCR), and Nonconformance Record (NCR) procedures. These procedures must be carefully developed with signatory authority clearly defined to address TxDOT’s residual risk.

3.5.2.4 TxDOT Guide Schedule Compliance

Another important QA activity is the CQAF adherence to the Guide Schedule. The Guide Schedule prescribes the minimum QA testing frequency for each type of material incorporated in the project. In accordance with the preamble to the Guide Schedule, it is expected that the QA perform higher testing frequencies during start-up operations. Testing frequencies may also be increased to investigate or address material quality issues. Only sample types of random independent are used to satisfy the Guide Schedule frequency, as described in Section 3.2.3 of the DB QAP.

When reviewing the QA portion of the CQMP for approval, TxDOT should verify the method that the CQAF will use to provide Guide Schedule compliance. Although each project is managed differently, some Developers will create a daily request for inspection and testing. This list is an anticipated volume of work that is distributed to the CQAF to request inspection and testing services. An example of the daily request is shown in Table 3.5-2. The CQAM will use this list to manage inspection and testing operations. Regardless of the methods employed, the actual quantity of items will need to be tracked by the CQAF, and the testing frequencies of the Guide Schedule will need to be applied. TxDOT should become familiar with the CQAF process used to verify compliance with the Guide Schedule, since audits will be conducted as described in Section 4.6.

Table 3.5-2: Developer Daily Testing Request

Week Starting: 10/25/2010						
Day and Date	Mix Design	QTY	Truck Spacing	Delivery Time	Used For / Location	Field Contact
Monday- 10-25-10						
Delivery # 1	C-30% DS	15	20 Min	9:00 AM	Crossland - Drill shafts	John Doe (123-555-1212)
Delivery # 2	C-30% DS	15	20 Min	12:00 PM	Crossland - Drill shafts	John Doe (123-555-1212)
Delivery # 3	C-30%-850	30	30 min	1:00 PM	BR2 bent22 columns	Jane Smith (111-222-1234)
Delivery # 4	C-30% DS	15	20 Min	3:00 PM	Crossland - Drill shafts	John Doe (123-555-1212)
Tuesday- 10-26-10						
Delivery # 1	C-30%-850	65	30 min	7:00 AM	BR40 bent 8 column	John Doe (123-555-1212)
Delivery # 2	C-30% DS	15	20 Min	9:00 AM	SH161/ Crossland - Drill shafts	Jane Smith (111-222-1234)
Delivery # 3	C-30% DS	15	20 Min	12:00 PM	SH161/ Crossland - Drill shafts	Jane Smith (111-222-1234)

3.5.2.5 Active Communication

An entire manual can be written on the importance of implementing active communication on DB projects. Active communication begins early in the project. To foster active communication for testing services, it is recommended that weekly materials coordination meetings be conducted between TxDOT, the OV materials manager, the CQAM, and the CQCM. If necessary, the weekly appointment can be extended to other members of the staff (e.g., resident engineers) as appropriate for the construction activities being discussed. An example of a weekly materials coordination meeting agenda is provided in Figure 3.5-2. Meeting minutes should be mandatory so that future reference to discussions and decisions can be made.

<i>Weekly Materials Coordination Meeting</i>	
<u>AGENDA</u>	
Date: August 2, 2010	
Time: 7am – 9am	
Location: Field Office	
1.	Review and Approve Previous Meeting Minutes
2.	Split Sample Program
	a. Initiate split sample program for concrete operations
	b. Review of split sample results for embankment operations
3.	Production Operations
	a. Embankment operations, South of FM 123
	b. Drilled shaft operations, Bridges 2 and 3
4.	Safety
	a. Testing near haul routes
	b. Concrete bucket operations for columns
	c. Fall protection training – August 7 th (8am)
5.	Coordination and Communication
	a. Daily testing between QA and OV
	b. Use of engineering judgment
6.	Open Forum

Figure 3.5-2: Sample Agenda for Weekly Materials Coordination Meeting

In addition to the weekly materials coordination meetings, it is recommended that the management staff from all parties inform their respective team members of the need to provide active communication during field operations. Construction occurs rapidly during DB projects. With plan revisions occurring frequently, daily communication among all parties is imperative. One simple example is the importance of communication during earthwork operations. It is not uncommon for earthwork operations to begin with early start of construction plans. The pavement design process may still be ongoing, with final grade elevations yet to be determined. The QC staff must communicate work areas for lot determinations and lift numbers. The QA inspectors will be on-site and should implement testing once each lift is compacted. Since work areas may be small, the QC superintendent will be anxious to place the next successive lift if accepted by the QA staff; however, the OV staff will need the opportunity of testing the lot once accepted. Since the size of the OV staff is inherently smaller than the QA staff and might be dispatched to another work location, the OV will need to keep communication open with the QA staff members. It is critical that the QC and QA staff keep the OV staff as up-to-date as possible with ongoing activities and their respective tests and inspection hold points.

3.5.2.6 QA Documentation

The CQAF is required to perform documentation as described in Section 3.3.4 of the DB QAP. In general, this section requires factual evidence to document compliance with the approved CQMP. This documentation should cover both conforming and defective or deficient features. The QA will submit statements that all supplies and materials incorporated into the work are in full compliance with the terms of the contract documents. The format of the documentation should be furnished to TxDOT as stipulated in the approved CQMP. Lastly, documentation should be updated by the agreed upon timeframe following the inspection or test and should be readily available for review or audit.

QA documentation includes daily inspection and testing reports. Daily inspection reports are required to be signed and submitted within 24 hours after the work shift. Sampling and testing documentation is submitted within 2 days of test completion. The CQAF is also responsible for establishing an electronic system for recording all materials test results. These results are required to be transmitted to TxDOT in an XML format. In general, the CQAF test results are transmitted in a TxDOT-approved format that is easily accepted by I2MS and can be used for validation. The DB QAP requires that the CQAF inspection and material test results are simultaneously transmitted to both TxDOT and the Developer. The Developer should not receive the CQAF inspection or material test results prior to TxDOT. The intent of electronic reporting is to allow the Developer and TxDOT to make timely and accurate decisions on workmanship and material quality issues. Another QA documentation requirement is that the CQAF maintain a listing of technician training and certification.

3.6 Owner Verification Testing and Inspection Plan (OVTIP)

The DB QAP requires the development of an Owner Verification Testing and Inspection Plan (OVTIP) that describes the commitments of the owner for oversight of the Developer's work. TxDOT staff, or their designee, performs OV inspection and testing and conducts audits to verify the Developer's compliance with the approved CQMP. Careful review and approval of the CQMP is very important because the CQMP will serve as the "practical rule book" against which the Developer's QC and QA work will be evaluated. With that said, the CQMP does not supersede the contract in precedence and cannot be used to change the DB QAP or other contract requirements. TxDOT has created a programmatic OVTIP manual that can be used as a starting point in developing a project-specific OVTIP. The information that follows provides guidance on the general content of the OVTIP and items that should be considered when developing a project-specific OVTIP manual.

3.6.1 Contents of OVTIP

In general, the OVTIP addresses the functions of various project personnel while performing construction-related inspections, as well as sampling and testing of various materials. The CQAF is responsible for acceptance of inspected items and material testing results. The primary function of the OV staff is to oversee the CQAF's inspections and to validate or verify CQAF test results. As such, the majority of the procedures in the OVTIP manual should identify means to perform the validation and not necessarily be detailed, step-by-step methods of inspection and testing. The procedures should, however, provide a sufficient level of detail so that any team member can identify procedures associated with their role and how they are accomplished under different scenarios.

3.6.2 OVTIP Commitments

The OVTIP manual should include the internal procedures used by TxDOT to verify that the Developer's frontline acceptance is performed in accordance with the approved CQMP. Section 3.4.2 of the TxDOT DB QAP provides the commitments that the OVTIP should specifically address, listed as A through O below. These commitments include testing as well as inspection activities.

- A. Methods and procedures that clearly define the authority and responsibility for the administration of OVTIP.
- B. Procedures for overseeing and inspecting the Work for compliance with the Developer's CQMP for each operation.
- C. Procedures to ensure that the education, training, and certification of personnel performing OV activities are achieved and maintained and that all Work is performed in accordance with the approved OVTIP.
- D. Procedures to oversee the status and disposition of any identified noncompliance with the plans and specifications.
- E. Measures to ensure that tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly maintained, controlled, calibrated, certified, and adjusted at specified periods to maintain accuracy within industry standards.
- F. A system of planned and periodic audits of Developer's CQMP to determine adherence to and the effectiveness of the CQMP. Audit results shall be documented, reviewed, and sent to TxDOT and the Developer. Follow-up action, including re-audit of deficient areas following corrective action, shall be taken where indicated.
- G. A system of planned and periodic audits of the OV firm to determine adherence to and the effectiveness of the OVTIP. Audit results shall be documented, reviewed, and sent to TxDOT. Follow-up action, including re-audit of deficient areas following corrective action, shall be taken where indicated.
- H. Procedures for performing periodic inspection of Work to verify that the CQAF has performed work in compliance with the released-for-construction plans, specifications, and approved working and shop drawings. The procedure should identify a target oversight inspection rate and methods for performing verification inspections for all QC and CQAF inspectors.
- I. Procedures on how OV material sampling and testing will be performed, including the process for generating random test locations, tracking material samples, processing material samples, review and approval of test records, and tracking compliance with material testing frequency.
- J. Procedures for reviewing QA and OV test results for compliance with mutually agreed-upon processes and naming conventions to ensure data integrity for accurate statistical analyses.
- K. Procedures for ensuring that only tests performed by qualified CQAF testing personnel are submitted to TxDOT.
- L. Procedures for auditing of QC and QA records, documentation, procedures, and processes to verify compliance with the CDA Documents and approved CQMP.
- M. Procedures for reviewing Portland cement concrete, soil-lime treatment, soil-cement treatment, and hot mix asphaltic concrete mix designs.

- N. Procedures for ensuring OV testing shall be performed at the frequency stipulated in this QAP.
- O. Procedures for performing statistical analyses in compliance with procedures outlined in this QAP.

3.6.3 Developing the OVTIP Manual

When developing the OVTIP, note that the commitments listed above might require that several individual procedures be developed to fulfill the commitment. Consider the following example using commitment “I”, repeated below for clarity.

- I. Procedures on how OV material sampling and testing will be performed, including the process for generating random test locations, tracking material samples, processing material samples, review and approval of test records, and tracking compliance with material testing frequency.

Procedure A: Describe process for generating random test locations to include random numbers procedures and tables.

Procedure B: Describe process for tracking material samples, processing material samples, and review and approval of test records.

Procedure C: Describe the method that will be used to track compliance with material testing frequency.

Table 3.6-1 provides a snapshot of example content for the OVTIP Table of Contents. An expanded version of this Table of Contents with individual procedures is contained in Attachment H.

Table 3.6-1: OVTIP Table of Contents (snapshot of suggested content)

Procedure No.	Title	Procedure Date	Revision No.
	Section 1 – Program Description		
	Section 2 – General		
	Section 3 – Construction		
	Section 4 – Inspection: Earthwork		
	Section 5 – Inspection: Subbase and Base Courses		
	Section 6 – Inspection: Surface Courses or Pavement		
	Section 7 – Inspection: Structures		
	Section 8 – Inspection: Incidental Construction		
	Section 9 – Inspection: Lighting and Signing		
	Section 10 – Inspection: Toll Gantries		
	Appendix A – Reference Procedures		

To provide additional clarity on the development of individual procedures contained within each section listed in Table 3.6-1, Attachment H also provides an example OVTIP procedure for roadway excavation. Note that the OVTIP manual is a large document and may take several months to develop. Like the CQMP, the OVTIP is a “living” document and will need to be updated periodically. These updates are necessary since construction will begin prior to final design being completed, and new, unanticipated features of work might be incorporated by the Developer. Additionally, when the CQMP is modified, the OVTIP procedure will require updating to provide guidance on oversight responsibilities.

3.7 Independent Assurance Program

The independent assurance program is implemented by TxDOT, or its designee, to evaluate all sampling and testing procedures, personnel, equipment, and laboratories that will be used as part of the acceptance decision. This program provides uniform procedures to verify that tests are performed by qualified personnel and that laboratory facilities and equipment are adequate to perform the required sampling and testing methods. Section 4.0 of the DB QAP provides an exhaustive list of the various requirements of the program.

With most DB projects, the pace of construction is extremely quick. Manpower curves are normally established to bring construction inspectors and testing technicians to the project at optimal periods based on the volume of anticipated work. Careful administration of the IA program is essential to the success of the overall project so that unnecessary delays are not encountered and testing technicians and laboratories are evaluated in a timely manner. TxDOT’s I2MS software, introduced in Section 3.2, provides the capability to electronically track the status of technician qualifications as an aid to managing the IA program.

The purpose of this section is to provide clarification on requirements and possible best practices to implement the IA program on a DB project.

3.7.1 Oversight of IA Program

Implementation of the IA Program is performed by TxDOT personnel; however, TxDOT has the option of designating an independent laboratory to administer the IA program on its behalf. When this option is utilized, personnel from the independent laboratory must be qualified by TxDOT CST.

3.7.1.1 Establishing the IA Laboratory

TxDOT will perform a site visit to assess the equipment to be used by the independent laboratory. Once qualified, the independent laboratory will designate certain personnel as IA assessors. These assessors are normally seasoned professionals of the independent laboratory that have a greater understanding of not only the test methods, but how these test methods are implemented within the laboratory and field environments. The role of the IA assessor is to perform an evaluation of project personnel and laboratories where test results will be used in the acceptance decision.

3.7.1.2 Scheduling and Fees

The IA laboratory requires notification by the QA or OV laboratory manager, normally one week in advance, when requesting laboratory and personnel qualification services from the IA laboratory. IA laboratory

scheduling of such requests is performed on a first come, first served basis. Every attempt should be made by the IA laboratory to accommodate an individual's request for qualification.

The QA and OV laboratory managers normally schedule the services of the IA laboratory directly through written correspondence with a carbon copy to the construction management oversight team. The written request should identify the technician's name and test procedures scheduled for examination.

If TxDOT is administering the IA program, TxDOT personnel will charge their time and expenses to the charge number assigned to the project. If TxDOT contracts with an independent laboratory, an agreement to provide IA services on a project is normally contained with the project contract (i.e., CDA) language. When developing the contract language for IA services, the project management oversight team should coordinate with TxDOT to establish arrangement of fees. In the end, fees for qualification under this program should not be charged to the individual technician or his employer, but instead as a pass-through cost to TxDOT or to the agency administering the IA program.

3.7.2 Laboratory Accreditation Process

Laboratory accreditation is a two-fold process. First, each laboratory will require accreditation through the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program (AAP). Second, each laboratory will be accredited in specific TxDOT test methods applicable to the DB project. Each of these processes is described in further detail below.

3.7.2.1 AASHTO Laboratory Accreditation

The AAP grants accreditation to laboratories that demonstrate competency in individual test procedures, using either American Society for Testing and Materials (ASTM) or AASHTO test methods. Since not all TxDOT test methods are directly equivalent to ASTM or AASHTO, careful consideration was given to select which ASTM and AASHTO test methods would require AASHTO accreditation, and most closely resembled the comparable TxDOT test methods. Tables are provided in Appendix H of the TxDOT DB QAP that lists the required AASHTO accreditation for various categories of materials.

AASHTO accreditation should not be required for the following two scenarios:

1. Any ASTM or AASHTO test method that is a significant departure from the TxDOT test method, or
2. Any ASTM or AASHTO test method that would require the purchase of specific test equipment that would only be used for obtaining accreditation in that test method.

Test methods that fall into the two scenarios described above should be qualified by the IA laboratory in the equivalent TxDOT test method and not by AASHTO accreditation.

3.7.2.2 TxDOT Laboratory Accreditation

The test methods listed in the Guide Schedule are TxDOT test methods unique to the State of Texas. Consequently, AASHTO does not accredit laboratories in these test methods, and accreditation will be administered by the IA laboratory. Upon successful completion of the TxDOT accreditation process, the IA laboratory will issue a Certificate of Accreditation in the applicable TxDOT test methods to both the QA and OV laboratories. An example certificate is provided in Attachment I.

3.7.2.3 Minimum Laboratory Standards

As previously stated, the minimum test methods required for laboratory accreditation are shown in Appendix H of the TxDOT DB QAP. These tables are separated by major material categories (e.g., HMA, Aggregate) and provide the ASTM, AASHTO, and/or TxDOT test method requiring certification. It is the responsibility of each laboratory to make arrangements directly with AASHTO for AAP accreditation. Additionally, each laboratory should coordinate for accreditation with the IA laboratory in the applicable TxDOT test methods. A requirement of the DB QAP is to maintain laboratory accreditation for the life of the DB project.

Since not all test methods are equivalent to TxDOT, a color-coded legend is included at the bottom of Appendix H in the TxDOT DB QAP that designates which ASTM or AASHTO test methods are “preferred” and which test methods are “acceptable” for the AASHTO accreditation process, along with the corresponding equivalent TxDOT test method. The legend also provides a color designation for those TxDOT test methods where no equivalent ASTM or AASHTO test method exists; these will be qualified by the IA laboratory.

It should be noted that Appendix H in the TxDOT DB QAP provides minimum requirements for laboratories to the extent that each test method is applicable to the project. If a particular test method listed in Appendix D will not be needed on the project, then accreditation is not required. Conversely, if changes to the project necessitate new test procedures, then accreditation in that test method will be required. If additional accreditation is required after the AASHTO or TxDOT accreditation has occurred, each laboratory will be qualified in the new test method by the IA laboratory, and further accreditation will not be required as long as the project is less than three years in duration. When the project duration is longer than three years, those new test methods will be added to the AASHTO and/or the TxDOT accreditation process.

3.7.3 Personnel Qualification Process

Section 4.2 of the DB QAP requires that technicians must be certified when performing sampling and testing as part of the acceptance decision. The IA laboratory has the responsibility to administer the personnel qualification process. A technician must maintain a current certification and must participate in the annual split-sample/proficiency program to be considered qualified.

3.7.3.1 Required Certifications

In general, each laboratory is required to provide sampling and testing personnel who have been certified from the American Concrete Institute (ACI) and/or the Texas Asphalt Pavement Association (TxAPA). The DB QAP explicitly states that “sampling and testing personnel must obtain and keep current the following certifications unless otherwise waived by governing specifications.” To implement this requirement, the QA and OV laboratories must make arrangements, well in advance, to have testing technicians available with the required certifications and ready to test on day one of the project. There are two reasons why this requirement was stipulated: first to have uniformity in certification requirements, and second to have technicians participate in the statewide proficiency program using samples developed and sent by TxDOT (e.g., Level 1A and SB 101 samples). If this requirement is waived by governing specifications, then the project oversight management team must realize that the IA laboratory must administer the annual split sample/proficiency program for those test methods normally covered by TxAPA.

When testing technicians transfer into the project with current certifications issued by TxDOT or another agency (i.e., not ACI or TxAPA), these certifications should be reviewed for applicability to the project. If these certifications have not expired and are acceptable for use, then further certification is not required.; however, when these certifications expire, the technician will be required to obtain ACI or TxAPA certification.

In the event that certain test methods are required on the project but are not administered by ACI or TxAPA, the IA laboratory will certify those technicians and provide a certificate that will expire after three years.

During the course of a project, there will be times when technician certifications expire. Scheduling through ACI or TxAPA should be made well in advance of the expiration date. In the unique situation where recertification cannot be made due to scheduling conflicts or certification cannot be attained prior to the start of construction operations, a six-month certification can be issued to the technician by the IA laboratory. These situations should be evaluated on a case-by-case basis. Before the temporary certification can be issued, the deviation from normal procedure must be approved by FHWA, and the testing technician should satisfy the following two conditions.

1. Successful completion of a written examination and demonstration of the test method in the presence of an evaluator from the IA laboratory and
2. Correspondence sent to the IA laboratory indicating that the technician is scheduled for the next available ACI or TxAPA course.

3.7.3.2 Certification by TxDOT IA Laboratory

In the event that technician certification is required by the IA laboratory, the following actions must be taken:

1. The QA or OV laboratory manager, or designee, develops a list of personnel who require certification along with the associated test methods. If a temporary certification is requested, then the laboratory manager will also indicate the ACI or TxAPA course date that the technician is scheduled to attend.
2. The list is sent to project management oversight team formally requesting technician certification by the IA Laboratory.
3. The project management oversight team schedules the IA Laboratory to administer the technician certification using a qualified assessor.
4. The IA Laboratory will provide an Inspection Preparation Checklist to the QA or OV laboratory manager. This checklist provides information on how the materials should be prepared for the test method prior to the arrival of the evaluator.
5. A written examination and performance evaluation will be provided to the technician by the assessor.
6. Upon successful completion of the evaluation, a technician certificate will be issued, similar to the example provided in Attachment J.

3.7.3.3 Training

This IA program is not intended to train technicians. Technicians should be experienced in the performance of each test method prior to attempting certification. The IA laboratory will only administer the written examination and performance evaluation.

3.7.3.4 Test Format

In general, both the written and performance examinations administered under the IA program are based on the latest TxDOT test methods found online at the following URL:

http://www.dot.state.tx.us/business/contractors_consultants/test_procedures/test_procedures.htm

The exams are considered “open book,” and reference material may be used during both the written and performance portions. With respect to the written examination, the technician will be required to achieve a minimum score of 80 percent. Successful performance is defined as demonstrating the ability to properly perform each test procedure. The technician must complete each step in a specific test procedure correctly during the performance examination. If a technician fails to demonstrate the ability to successfully perform a test, the technician will be allowed one retest per test procedure at the evaluator’s convenience prior to completion of the scheduled visit. If the technician fails the retest, the technician is deemed as having failed that test method. A technician failing either portion of the examination will be given one opportunity to retest the failed portion of the examination. Should the technician fail this retest examination, the technician will not be allowed to test again unless the IA laboratory receives a letter from the technician’s employer stating that the technician has received additional training.

Scoring of the written and performance examinations will be done during IA laboratory’s on-site visit. The result of the performance exam will be either “Pass” or “Fail.” The written examination will be reported as a percentage of correct answers. The technician will not receive a copy of the graded written examination; however, they will have the opportunity to debrief with the evaluator. If a technician believes that a correct answer was counted wrong, disagrees with the explained correct answer, or questions the evaluator’s determination during the performance examination, the technician can submit a written challenge to the Qualification Board, as discussed further in Section 3.7.5.

3.7.3.5 Test Security

In general, there are three possible examinations for qualification in an individual test procedure. Each examination consists of multiple questions, and no examination is considered more difficult than the others. The IA laboratory will randomly select one examination for each test procedure indicated in the request, which will be provided to the technician on the day of the written examination. All examinations will be collected by the IA laboratory upon completion. In an effort to maintain security of the examination, no exams will be permitted to leave the testing area. The evaluator will verify that all examinations listed on the technician’s packet have been turned in at the end of the examination period. Upon grading these examinations, the evaluator will securely file the results at the IA laboratory.

3.7.4 Annual Split/Proficiency Evaluation

Technicians will also be required to participate in annual split sample testing and proficiency evaluations to maintain their certifications. For those technicians who are certified by TxAPA, participation in the TxAPA

Proficiency Sample Program is required, and TxDOT will supply proficiency samples for the certifications listed below.

1. SB 101 – Soils and fine aggregate testing,
2. SB 201 – Base material testing, and
3. Level 1A – Hot-mix asphalt testing.

Table 3.7-1 summarizes the requirements of the annual split/proficiency program as defined in Appendix F of the DB QAP. Note that Table 3.7-1 contains project-level split samples for concrete fresh and hardened properties and that all other evaluations are based on samples obtained through TxDOT's annual proficiency program. The results of the split samples are evaluated using the acceptable tolerance limits defined in Appendix B of the DB QAP, whereas the TxDOT proficiency program uses a rating system based on statistical analysis of data.

As stated in Section 3.4.1, the DB QAP requires that sampling and testing personnel must obtain and keep current certification through TxAPA. If testing personnel do not obtain certifications through TxAPA, then proficiency samples will not be sent to the technician from TxDOT. This will require that batching of samples, as well as any associated analysis of data, be included within the scope of services for the IA laboratory.

Table 3.7-1: Summary of Annual Proficiency Testing Requirements

Test Method	Description	Proficiency Program
Tex-104-E	Determining Liquid Limit of Soils	TxAPA SB 101
Tex-105-E	Determining Plastic Limit of Soils	TxAPA SB 101
Tex-106-E	Calculating the Plasticity Index of Soils	TxAPA SB 101
Tex-107-E	Determining the Bar Linear Shrinkage of Soils	TxAPA SB 101
Tex-110-E	Particle Size Analysis of Soils	TxAPA SB 101
Tex-200-F	Sieve Analysis of Fine and Coarse Aggregate	TxAPA Level 1A
Tex-206-F	Compacting Test Specimens of Bituminous Mixtures	TxAPA Level 1A
Tex-207-F	Determining Density of Compacted Bituminous Mixtures	TxAPA Level 1A
Tex-227-F	Theoretical Maximum Specific Gravity of Bituminous Mixtures	TxAPA Level 1A
Tex-236-F	Determining Asphalt Content from Asphalt Paving Mixtures by the Ignition Method	TxAPA Level 1A
Tex-414-A	Air Content of Freshly Mixed Concrete by the Volumetric Method	Project Split Samples
Tex-415-E	Slump of Portland Cement Concrete	Project Split Samples
Tex-416-A	Air Content of Freshly Mixed Concrete by the Pressure Method	Project Split Samples
Tex-418-A	Compressive Strength of Cylindrical Concrete Specimens	Project Split Samples

3.7.4.1 Evaluation Schedule

Table 3.7-2 provides a suggested schedule of activities for the annual split/proficiency evaluation. Results are summarized for the calendar year and are used to generate an FHWA annual report, as described in the next section.

3.7.4.2 Annual Reporting Requirements

As part of the administration of the IA program, the IA laboratory will submit an annual report summarizing the results of the IA program to TxDOT each January. The contents of the annual report are described below, and a sample letter is provided in Attachment K for the reader's convenience.

Table 3.7-2: Example Schedule of Activities for IA Evaluation

Anticipated Month	Activity Description
<i>Soil – Base (SB 101) TxAPA Proficiency Evaluation</i>	
November	SB 101 samples sent
December	SB 101 participants respond
January	SB 101 results published
<i>Hot-Mix Asphalt Level 1A TxAPA Proficiency Evaluation</i>	
December	Participant registration
January	Level 1A samples sent
March	Level 1A participants respond
June	Level 1A results published
<i>Hydraulic Cement Concrete Split Sample Evaluation</i>	
October	Project split samples performed
December	Results published
<i>TxDOT Annual Report</i>	
December	Data gathered
January	Report generated

1. Number of personnel evaluated through the IA program:
 - a. Since proficiency evaluations are being conducted through TxAPA, this value will generally consist of only the number of project personnel who participated in concrete split sample evaluations.
 - b. As an example, if 25 project personnel participated in concrete split samples, the number reported would be equal to 25.
2. Number of IA evaluations meeting tolerance:
 - a. This will include the number of tests performed by each technician who successfully met the tolerances listed in Appendix B of the DB QAP.
 - b. As an example, if the 25 personnel in Item 1 were evaluated on three tests each (e.g., slump, air content, and compressive strength) then the number of evaluations would be equal to 75. If three individuals did not meet tolerances, then the number reported would be equal to 72.

3. Number of IA evaluations not meeting tolerance:
 - a. Based on the examples provided above, the number reported for the evaluations not meeting tolerance would be equal to 3.
 - b. Any corrective actions taken.
4. This portion of the annual report discusses the corrective actions taken by the laboratories for those technicians that did not meet the split proficiency evaluation tolerances.

3.7.5 Disqualification

It is the intent of the IA program to afford each technician a fair and unbiased opportunity to achieve TxDOT certification by the IA laboratory. Each technician that participates in the program will be required to pass both a written examination and a performance examination. If a technician believes that a correct answer was counted wrong, disagrees with the explained correct answer, or questions the evaluator's determination during the performance examination, the technician will have five days to submit a written challenge. The following section describes the creation of a project-specific Qualification Board, as described in the DB QAP. The Qualification Board is an industry best practice to be used on a DB project to formally address qualification disputes and disciplinary actions.

3.7.5.1 Qualification Board

Table 3.7-3 provides the recommended arrangement of the Board. An odd number of members should be used to provide a majority rule decision when casting votes.

Table 3.7-3: Members of the Qualification Board

Position	Project Affiliation
Project Engineer	TxDOT District Office or Agency Representative
Construction Manager	Owner Representative
Statewide Program Manager	TxDOT CST/M&P
Construction Manager	Developer
Quality Control Manager	Developer

3.7.5.2 Disqualification Process

It is imperative that misconduct by testing technicians be addressed quickly and appropriately to provide integrity to the entire QAP. The three levels of misconduct are neglect, abuse, and breach of trust, defined in Table 3.7-4.

Allegations of misconduct should be made to the Qualification Board in writing. The allegation should contain the name, telephone number, and signature of the individual making the allegation. The board should protect the identity of the person who raises a concern of an alleged wrongdoing. Upon receipt of the allegation, an investigation will be made and the Qualification Board will determine the appropriate course of action. If the allegation appears to be warranted, the accused will be notified of the opportunity to appear at a Board meeting for resolution of the allegation. Penalties may be implemented by the

Qualification Board and may range from a reprimand to a permanent revocation of the certification. Any technician who is found guilty of breach of trust will have their certification permanently revoked. Any technician with a revoked certification will be removed from the project and will not be allowed to be employed on any TxDOT project statewide. The Qualification Board will notify all involved parties, in writing, of the findings, and its decision is considered final.

Table 3.7-4: Levels of Misconduct

Term	Definition
Neglect	Unintentional deviations from testing procedures or specifications
Abuse	Careless or deliberate deviation from testing procedures or specifications
Breach of Trust	Violation of the trust placed in the certified technician including, but not limited to, acts such as: <ul style="list-style-type: none"> • Falsification of records • Being aware of improprieties in sampling, testing, and/or production by others and not reporting them to appropriate supervisors involved in the project • Resampling and/or retesting without awareness and consent of appropriate supervisors involved in the project; and/or • Manipulating compensation and/or production

3.7.6 Documentation

The IA laboratory is responsible for securely maintaining all records for the IA program. Records should be maintained for the life of the project. Upon completion of the project, disposition of the qualification records will be determined by the Qualification Board.

3.7.6.1 Requirements for Technician Records

The IA laboratory will maintain a file for each technician who has tested under the program. At a minimum, the file will contain:

1. Full name of technician.
2. Name of employer.
3. Copies of any qualification certificates issued by ACI and TxAPA.
4. Original written examinations for each test procedure administered by the IA laboratory. The examinations should clearly identify the technician's name, qualifier's name, score, and date taken.
5. Original performance examinations for each test procedure administered by the IA laboratory. The examinations should clearly identify the technician's name, qualifier's name, score, and date taken.
6. Split Sample test results.
7. Re-qualification status and associated documentation.

8. Copies of any test challenges and Qualification Board decisions.
9. Copies of any disciplinary action taken by the Qualification Board.

3.7.6.2 Requirements for Laboratory Records

The IA laboratory will maintain a file for each laboratory that has participated in the program. At a minimum, the file will contain:

1. Name of firm.
2. Physical location of laboratory.
3. Name of contact person of laboratory.
4. Name of Qualifier.
5. Laboratory inspection reports to include items 1 through 3 above, as well as the date of inspection.
6. Deficiencies and associated follow-up documentation.
7. Copies of any qualification certificates issued.
8. Re-qualification status and associated documentation.

3.7.6.3 Implementing the IA Program Using TxDOT's I2MS

TxDOT has developed a secure web-based software program called I2MS to manage and analyze the QA and OV data and to automate some of the requirements contained in the DB QAP. To help manage the IA program, I2MS contains functionality for technician qualification tracking and verification of test result submission against technician qualifications. This capability ensures that QA and OV tests are submitted only by qualified testing technicians. The IA laboratory should use I2MS to store technician qualifications and to document technician participation in the annual split/proficiency program.

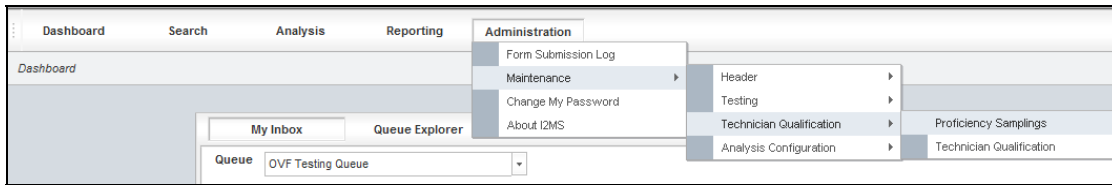
In general, the IA laboratory should maintain the following information within I2MS:

1. Full name of technician.
2. Name of employer.
3. Test methods qualified to perform (by TxDOT test designation).
4. Expiration date of each qualified test method.

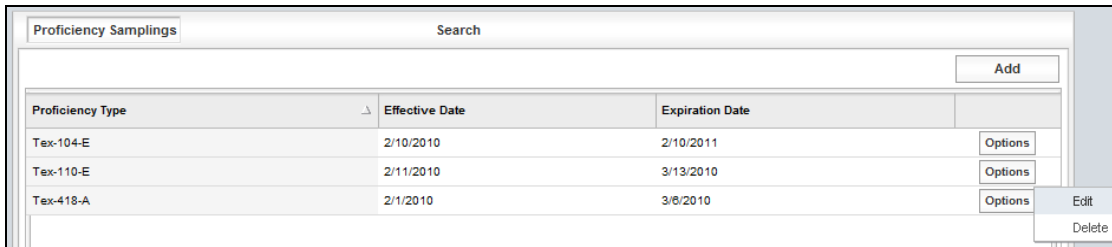
The IA laboratory should update the above information in I2MS within 48 hours of a technician's change in status. Change in status is defined as obtaining qualification for test methods not previously qualified and disqualification or expiration of any previously qualified test method. Disqualification may be the result of disciplinary action by the Qualification Board or by failure to complete the re-qualification process.

TxDOT has developed a Quick Reference Guide for I2MS, which can be obtained by contacting CST. Figures 3.7-1 and 3.7-2, taken from the Quick Reference Guide, illustrate the commands used to manage proficiency samples and technician qualifications, respectively.

(a) Accessing Proficiency Samplings through Administration Tab



(b) Proficiency Samplings Main Screen



(c) Editing Proficiency Samplings

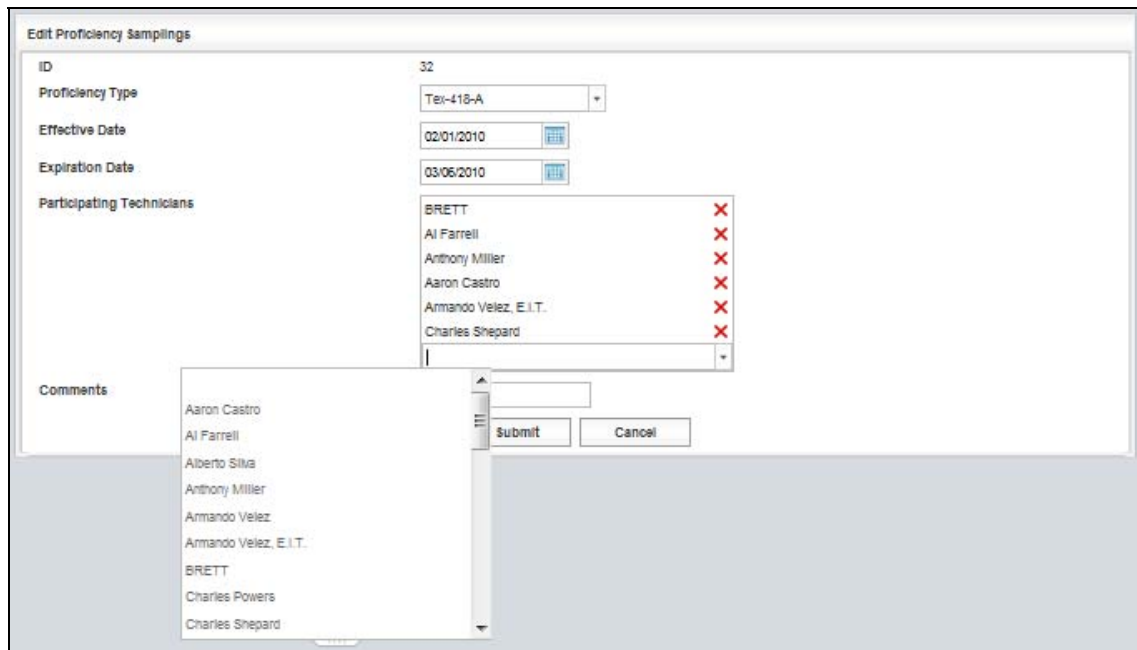
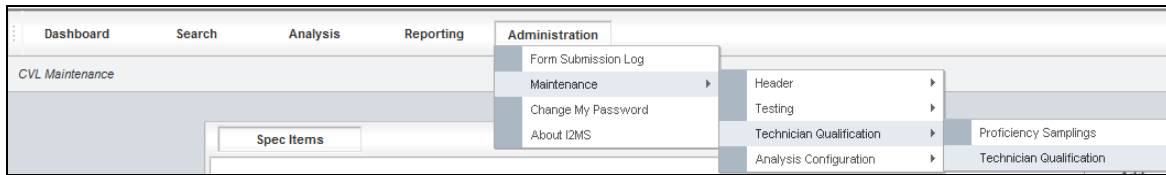


Figure 3.7-1: Managing Proficiency Samples using I2MS

(a) Accessing Technician Qualifications through Administration Tab



(b) Technician Qualifications Main Screen

Technician Qualification Search Add

Technician	Qualifying Agency	Qualification	Authorized Date	Expiration Date	Override	Ignore Proficiency	Options	Edit
Aaron Castro	HMAC	Level IA	10/17/2008	10/17/2011	No		Options	Edit
Aaron Castro	HMAC	SB 201	1/1/2010	1/1/2011	No		Options	Delete
Aaron Castro	HMAC	SB 202	9/21/2007	9/21/2010	No		Options	
Aaron Castro	HMAC	SB 202	1/1/2010	1/1/2011	No		Options	

(c) Editing Technician Qualifications

Edit Technician Qualification

ID: 1676

Technician: Al Farrell Edit

Qualifying Agency: ACI

Qualification: Field Testing Technician Grade I

Authorized Date: 05/12/2007

Expiration Date: 05/12/2012

Override:

Ignore Proficiency:

Comments:

Dropdown menu options: ACI, ACI, HMAC, Rodriguez Engineering Labora, TxDOT, Level IA, Level IA, Level IB, Level II, SB 101, SB 102, SB 103, SB 201, SB 202

Figure 3.7-2: Managing Technician Qualifications using I2MS

3.7.7 Tracking of Technician Qualifications in I2MS

TxDOT’s I2MS software provides the capability to electronically track the status of technician qualifications as an aid to manage the IA program. The DB QAP requires that each technician performing testing that will be used in the acceptance decision be qualified by having a current certification and showing proof of participation in the annual split sample/proficiency sample program. More information on how to use this feature of I2MS is contained in TxDOT’s I2MS Quick Reference Guide and in Section 4.1.4.3 of this guide.

3.8 Laboratory Alignment

During start-up operations for each type of material defined as Level 1 or Level 2, the QA is required to perform split sample testing with the OV to verify that both laboratories' testing procedures and equipment are in alignment. It is imperative that both laboratories agree to use the same version and release date for the particular test method. In addition, discussions and agreements should take place prior to split sampling on the method(s) of sample preparation so that both labs are preparing the samples using the same protocol. In general, and when no egregious modifications to procedures occur, the OV lab should conform to execution methods performed by the QA lab. Lastly, both laboratories should thoroughly discuss any alternative methods that are potentially allowed in the test procedure prior to split sample testing. Both labs are considered aligned when the split sample results are within the operational tolerances defined in Appendix B of the DB QAP; however, past experience has shown that it is vitally important to obtain split sample results that are closer than the allowances of the operational tolerances, as statistical validation of Level 1 tests generally have tighter bands of validation acceptance. It should also be noted that split sample evaluation is conducted per test method and not necessarily for each material source identified in Appendix B of the DB QAP. For example, split samples will be conducted for gradation. If gradation split samples are conducted for embankment, then those operational tolerances will apply. Note that the split sample operational tolerances for gradations are different for hot-mix asphalt. Additionally, split samples should be conducted for slump using a single mixture "class," not necessarily for each mixture type on the project. It is suggested that split samples be performed periodically throughout the life of the project as necessary to investigate non-validating material categories and verify or realign sampling methods, testing equipment, and personnel.

A question that arises during implementation is how many samples are required during the split sample program. It is suggested that five split samples be taken during start-up operations. If a majority of these split samples are within the defined operational tolerances, then alignment is generally believed to have occurred. For those test methods that do not validate during start-up operations, both the CQAF and OV firm will collaborate to determine the cause(s) of the non-validation, and both will take appropriate corrective actions during the early phases of material production to align the testing operations. Investigations include the evaluation of sampling and testing procedures and laboratory equipment. If questions concerning the correct process of performing a test method arise, the IA laboratory can be contacted to provide guidance.

When split samples are taken during production operations, the QA may use its split sample results for acceptance, if it is a random sample; however, the QA laboratory may not count its split samples used purely for testing and equipment alignment for acceptance.

Split samples taken during start-up operations do not replace or relieve the requirements of the annual split sample/proficiency program administered as part of the IA program nor do they relieve the requirements for random-independent samples.

3.9 Section Summary

This section provided the implementation steps necessary to start a DB project. The first major step is to establish a clear submittal review process so that prompt and thorough reviews by TxDOT will allow the project to move forward rapidly without major delays. Key submittal topics that will need to be reviewed are summarized in Table 3.1-2. The first major submittal will be the Developer's CQMP. This is a major

document that includes the process and procedures for delivery of QC and QA activities and will need to be approved by TxDOT and the FHWA 90 days prior to construction.

During the submittal review process, concurrent efforts will need to take place to deploy the I2MS software. Large volumes of data will be processed, stored, managed, and analyzed, and it is imperative that the deployment logistics be accomplished during project start-up. To assist in the effort, TxDOT has created an I2MS Deployment Guide along with a Quick Reference Guide to provide software training to project staff.

Comprehensive discussions were provided in this section on the QC and QA programs so that project-level staff understands the Developer's commitments and how these programs should be properly implemented during a project. Owner's requirements were also discussed, along with the need to finalize the OVTIP manual. A programmatic OVTIP manual has been created by CST/M&P but will require review and possible modification during project start-up to capture anticipated project-specific processes and procedures. Both the CQMP and the OVTIP are considered living documents and can be revised during project implementation.

The implementation efforts associated with the Independent Assurance program was also discussed in this section. Table 3.7-5 below summarizes the key points discussed.

Table 3.7-5: Section Summary of Key Points for the IA Program

Topic	Key Points
IA Program Administration	Performed by TxDOT or its designee.
Establish IA Laboratory	AASHTO accreditation required as well as review of TxDOT procedures and equipment by CST/M&P.
Verify Laboratory Qualifications	Ensure that QA and OV labs are adequate for the test methods to be performed.
Verify Personnel Certifications	Ensure that QA and OV personnel have the current certifications for the test methods to be performed.
Establish Split Sample/Proficiency Program	Perform split samples and verify proficiency testing have occurred for each testing technician.
Establish Dispute Resolution Process for IA Activities	Establish Qualification Board or other mechanisms for dispute resolution and disciplinary actions.
Maintain IA Documentation	Documentation should be maintained by the IA laboratory for technician certifications, laboratory accreditations, split samples, proficiency results, dispute resolution, and disciplinary actions.
Use I2MS	Use I2MS to manage and analyze IA data and technician certifications.

At this point in the implementation process, project staff should have:

1. Established and implemented Technical Working Groups (TWG) and Materials Coordination Meetings to expedite project deliverables and provide clear lines of communication between the Developer and Owner.
2. Established a submittal review process.
3. Deployed the I2MS software and conducted training for technical staff, supervisors, and project administrators.

4. Reviewed and approved the CQMP.
5. Developed a project-specific OVTIP manual.
6. Established the IA program and verify testing technicians and both the QA and OV laboratories are qualified to perform project testing.

4 Project Operations

4.1 Sampling and Testing Oversight

4.1.1 QC, QA, and the Role of OV Testing

The DB QAP provides requirements for QC, QA, and OV sampling and testing. As previously discussed, the role of QC testing is to monitor and verify that materials are produced and controlled with a focus that quality has been incorporated into the project. Testing for acceptance is performed by the QA staff with results verified by the OV firm. The QA and OV results are used together to form the basis for the acceptance decision.

The OV staff is substantially less than the QA staff; therefore, it is imperative that constant communication between firms takes place. Although the QA staff will become extremely busy on a DB project, it is in the interest of members of the QA firm to be proactive and promote active communication with the OV firm. If the OV firm is not notified and cannot sample and test, validation may not occur, which will cause the QA firm to be pulled into a non-validation investigation. During the initial phases of the project, it is strongly recommended that QC, QA, and OV firms develop a formal process of communication.

4.1.2 Frequency of Testing

The Guide Schedule provides minimum QA sampling frequencies for various construction materials. The DB QAP requires the CQAM to track and record the quantity of materials incorporated into the project. Higher testing frequencies by the QA staff are encouraged in the preamble of the Guide Schedule, especially during start-up operations or when concerns over the material quality arise. It should be noted that only random independent tests used for acceptance should be counted in meeting minimum testing frequencies. Since a random independent QA test is required for acceptance of every lot on the project, this should be relatively easy to achieve.

Frequency of testing by the OV is established in the DB QAP at the discretion of TxDOT. A higher initial testing frequency is used to establish confidence in the Developer-performed tests. TxDOT will conduct audits to verify compliance of both the QA and OV testing frequencies.

4.1.3 Sample Types

Section 3.2.1 of the DB QAP provides a description of the various sample types that can be used when performing sampling and testing. The sample type is used to differentiate how a sample or test location was determined. To be included in the statistical analysis for verification, the sample must be designated as a random sample type. It is imperative that both the QA and OV laboratories have a clear understanding of how to designate the sample type well before production begins. It is recommended that one or more meetings be held at the very beginning of the project to address this topic. Table 4.1-1 provides a description of the various sample types that will be encountered on a DB project.

Table 4.1-1: Sample Types

Sample Type	Description
Random Sample	The sample location was identified by applying a random number methodology to the entire sample lot such that each identifiable portion of the lot has an equal opportunity to be sampled and tested. The method used for determining random samples should be described in both the CQMP and the OVTIP.
Independent Sample	OV and QA samples and tests are obtained independent of one another.
Random Independent Sample	A sample that was obtained independent of either the OV or QA sample with the sample location identified by applying a random number methodology.
Random Split Sample	A random number was used to obtain the location for a sample to be tested by the QA and OV.
Fixed Split Sample	The sample location of a split sample is determined by any method other than the use of random numbers.
Fixed Independent Sample	The sample location is not determined by random numbers, such as due to a localized concern, and is also independent.
Internal Sample	A test or sample that is performed for a firm's internal use, such as periodic quality control of testing methods or equipment.
Not Incorporated Sample	Used when a test report has been previously entered into I2MS, but the material has been removed and replaced, and its status needs to be changed to remove it from being included in the verification analysis.

4.1.4 Program Oversight using I2MS

I2MS is robust software for performing the OV function on a project with Developer tests being used for acceptance. The TxDOT Materials Manager can use this software to track the status of various tests, analyze trends in materials, and allows for active materials management of the project. The core functionality of this software is described below and in the subsequent sections.

1. Security and Permissions,
2. Data Entry and Workflow,
3. Technician Qualification Verification,
4. Use of Controlled Vocabulary Lists,
5. Search,
6. Graphing Data, and
7. Three-Tiered Verification Approach.

4.1.4.1 Security and Permissions

I2MS has been deployed by TxDOT to perform validation of Developers' test results used in the acceptance decision on over \$5 billion of projects in Texas. Security and permissions are an important component of any software to protect the integrity of the test results and corresponding statistical analyses.

I2MS has role-based and user-based authentication to ensure groups and users are only granted access needed to perform their roles on the project. It stores encrypted passwords for each user using industry

standard encryption techniques and has customizable password rules in place to protect against password guessing. I2MS also has a server side certificate to authenticate all communication using secure socket layer (SSL) technology.

Users are generally divided into three primary user groups. The first group is the “technician” group responsible for entering data into the system. This group contains staff responsible for performing the tests and/or entering the test reports into the system. The second group is the “supervisor” group. This group is generally responsible for reviewing the data entered into the system by the “technician” group and approving the test reports. The third group is the “OV manager” group responsible for performing data and statistical analysis. The interaction between the three primary groups is described further in Section 4.1.4.2.

In addition to the three primary user groups, there is another group with access to enter and monitor the CVL. This functionality is described further in Section 4.1.4.4. Finally, there is the system administrator who will have broad access to I2MS. The system administrator is not a member of the project team and requires special authorization from TxDOT CST to make system-level changes to the software.

4.1.4.2 Data Entry and Workflow

There are two primary sources of data entered into I2MS for storage and analysis. The first set of data is the Developer’s QA test results used as part of the acceptance decision. I2MS can accept QA test results using extensible markup language (XML) data transfer or through direct entry into the system. TxDOT’s OV test results are typically entered directly into the system.

When data are transferred into I2MS using XML data transfer, only sample/test location and final test results are transmitted into I2MS. When data are transferred in this manner, the test results would have been reviewed by the Developer’s laboratory staff for accuracy prior to data transmission. Once data are received in I2MS, the test report is directed to the OV Materials Manager via the system’s workflow process for the OV Materials Manager to perform a general review of the report before approving it for analysis.

For data input directly into the system, there is a different workflow process. Technicians or data entry personnel enter the test results into the system. Each test report is comprised of a header, a body, and a footer section. The “header” consists of data fields that describe the sample/test location and the type of test. The “body” contains raw test data and calculated result fields for the test method. The “footer” contains data fields that identify the testing technician, the supervisor, the test completion date, report approval date, and notes or comments that may be included with the report.

It should be noted that I2MS is not the repository for test results. Any documentation or paperwork that corresponds to the material in question must be maintained by the respective QA or OV firms and stored for at least three years after project completion.

Reports directly entered into the system may be saved as drafts prior to submission of the completed test report. Once the completed test report is submitted, it follows the workflow to the supervisor for action. The supervisor will review the test report and either approve it or reject it back to the technician for appropriate revisions. The supervisor may include notes to the technician on why the test report is rejected for revisions. When the supervisor approves the test report, it becomes available for analysis.

4.1.4.3 Technician Qualification Verification

Federal regulations require that all tests performed as part of the acceptance decision be performed by qualified technicians. In order to help monitor this requirement, I2MS has a technician qualification verification process. Each technician performing tests on the project submits their qualifications and their respective expiration dates to TxDOT for entry into I2MS. The mandatory annual proficiency program participation compliance is also entered into the system. Figure 4.1-1 shows an example of a technician's qualifications user interface.

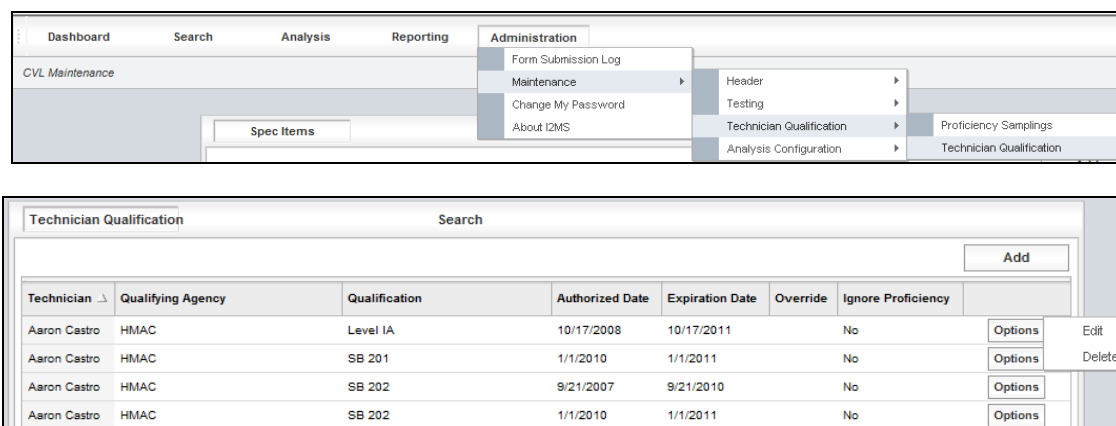


Figure 4.1-1: Example of Technician Qualification User Interface

When test reports are submitted for approval, I2MS automatically verifies the technician's qualifications for that specific test method before allowing the test report to be approved. If the technician does not have the proper qualifications, the system provides an error message and the test report cannot be approved.

4.1.4.4 Use of Controlled Vocabulary Lists (CVL)

On large projects, there will be several types of materials used on the project. Within each material type (e.g. Portland cement concrete, embankment,) separate materials must be put into distinct categories for analysis. For example, different Portland cement concrete mix designs should be put into distinct categories so that they will not be analyzed together.

As important as it is to establish the correct categories for analysis, it is equally important to have uniform naming convention fields to ensure that each test report is placed in the correct category for analysis. For example, one person may identify a supplier as "John's Concrete Plant," while another may identify the same supplier as "John's Concrete." The analysis will treat reports with two different names as different suppliers. In order to avoid this problem, CVLs are created for each data field that may encounter this problem. A very small number of people are in the user group that controls the CVLs. They are responsible for making sure that only legitimate new terms are added to the existing CVLs. Figure 4.1-2 shows some of the typical header data field CVLs.

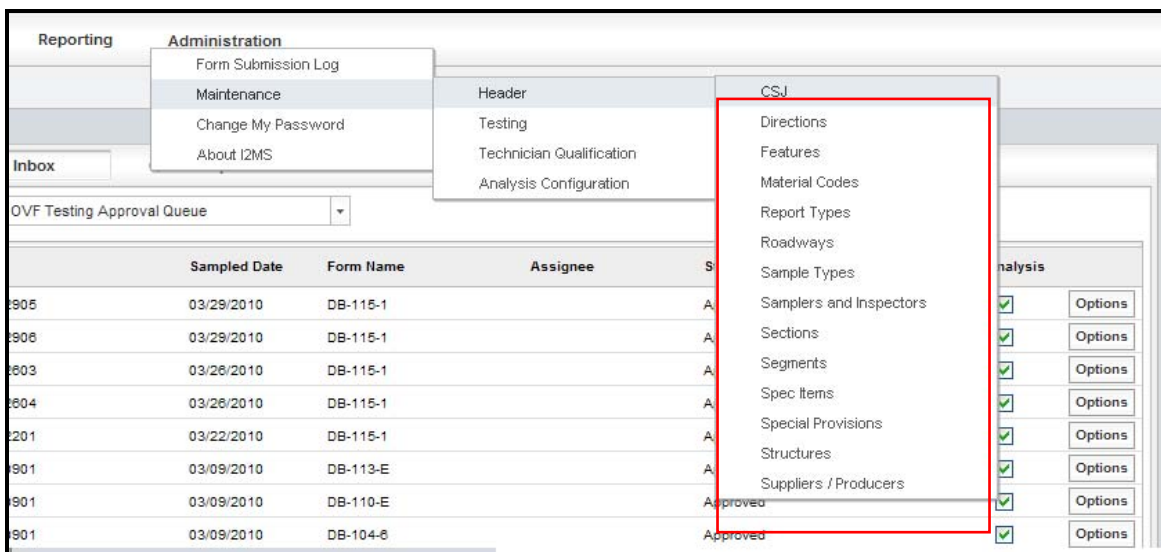


Figure 4.1-2: Examples of Controlled Vocabulary List Header Fields

4.1.4.5 Search

As with any large database, the ability to search for specific information in the database is critical. I2MS allows users to search for data based on using one or a combination of all the header data fields. This includes the ability to search for test results for a given structure, within a given station range, or tests performed by a specific technician. The system also allows users to search for tests based on the approval status (draft, pending, approved, etc.). Figure 4.1-3 shows the user interface for the search feature.

4.1.4.6 Graphing Data

In addition to storing and searching for data, it is also important to be able to graph and review trends in data. Specifically, I2MS has the ability to plot trends in data (one property versus time) or plot data analysis (one property against a second property). The same data fields available in the search function are available to isolate and retrieve data for graphing. These graphical representations allow the user to quickly see trends in the data. The resulting graphs can be viewed within I2MS or downloaded to various electronic file formats. Available download formats include Microsoft Excel and other commonly used formats.

Figure 4.1-3: I2MS Data Search Fields

Based on these trends, the user can visually identify some inconsistencies or troubling trends. An example of inconsistencies are data points that appear as anomalies. These may be due to incorrect use of the sampling/testing location information, errors in the testing process, true outliers, etc. These graphs may also identify material properties that are trending toward not meeting specifications.

4.2 Verification Analyses

The development of TxDOT's three-tiered approach is based on very practical lessons learned from previous projects and national guidance provided by FHWA. The fundamental principle behind the three-tiered approach is to assign the appropriate level of resources to monitor and evaluate each analysis category based on TxDOT's residual risk after the Developer has completed construction and fulfilled its maintenance obligations. In general, the higher the residual risk for the performance of the material after the Developer's maintenance obligations expire, the higher the level of monitoring and verification. For example, concrete on a bridge structure is typically designed and constructed to perform over a service life significantly longer than 15 years (length of optional maintenance agreement on TxDOT DB projects,) so TxDOT has significant residual risk after the 15-year capital maintenance agreement has expired. Similarly, the stronger the relationship between the material property being tested and the material's performance, the higher the level of monitoring and verification required. For example, the compressive strength of concrete is a significantly better indicator of performance than the concrete slump. Therefore, compressive strength of concrete calls for Level 1 analysis, while concrete slump does not.

Table 4.2-1 shows the first page of the default analysis category table contained in the TxDOT DB QAP. This table was developed using the required test methods contained in the Guide Schedule. A default level of analysis (1, 2, or 3) was assigned to each test for each analysis category (a combination of "material or

product” and test method). Level 1 has the highest residual risk to TxDOT and/or a strong correlation to the performance of the material being tested. It should be noted that Level 1 analysis categories require a sufficiently high testing frequency in order to have sufficiently powerful statistical analyses.

Table 4.2-1: Example Analysis Categories for Owner Verification

Levels for Analysis		Level 1	Level 2	Level 3
EMBANKMENTS, SUBGRADES, BACKFILL, AND BASE COURSES				
MATERIAL OR PRODUCT		TEST FOR	TEST NO.	TxDOT RECOMMENDED
EMBANKMENT (CUTS & FILLS)		Liquid Limit	Tex-104-E	2
		Plasticity Index	Tex-106-E	1
		Linear Shrinkage	Tex-107-E	2
		Gradation	Tex-110-E	2
		Moisture/Density	Tex-114-E	3
	In-Place Density	Tex-115-E	1	
RETAINING WALL (NON-SELECT BACKFILL)		Liquid Limit	Tex-104-E	2
		Plasticity Index	Tex-106-E	1
		Linear Shrinkage	Tex-107-E	2
		Gradation	Tex-110-E	2
		Moisture/Density	Tex-114-E	3
	In-Place Density	Tex-115-E	1	
RETAINING WALL (SELECT BACKFILL)		Gradation	Tex-110-E	2
		Resistivity	Tex-129-E	2
		pH	Tex-128-E	2
		Soundness	Tex-411-A	3
		In-Place Density	Tex-115-E	1
UNTREATED BASE COURSES		Liquid Limit	Tex-104-E	2
		Plasticity Index	Tex-106-E	1
		Linear Shrinkage	Tex-107-E	2
		Gradation	Tex-110-E	2
		Moisture/Density	Tex-113-E	3
		Wet Ball Mill	Tex-116-E	2
		Triaxial	Tex-117-E	2
		In-Place Density	Tex-115-E	1
		Moisture Content	Tex-103-E	2
		Thickness	Tex-140-E	1
TREATED SUBGRADE AND BASE COURSES	New Base Material	Liquid Limit	Tex-104-E	2
		Plasticity Index	Tex-106-E	1
		Linear Shrinkage	Tex-107-E	2
		Gradation	Tex-110-E	2
		Moisture/Density	Tex-113-E	3
		Wet Ball Mill	Tex-116-E	2
		Triaxial	Tex-117-E	2
		In-Place Density	Tex-115-E	1
		Moisture Content	Tex-103-E	2
		Thickness	Tex-140-E	1
	Complete Mixture	Pulverizatin Gradation	Tex-101-E, Part III	2
		Moisture Content	Tex-103-E	2
		In-Place Density	Tex-115-E	1
		Thickness	Tex-140-E	1

While there are default levels set for each analysis category, each project has its own unique conditions that may warrant project-specific modifications to the default levels of analysis for some material categories. The risk workshop will evaluate project-specific contractual framework and conditions (e.g., soil conditions, past performance of project elements in the area) For example, the DB QAP assumes an optional 15-year capital maintenance agreement. If a DB project does not have a capital maintenance agreement, and maintenance of the project is the owner agency’s responsibility upon final acceptance, the owner’s residual risk is higher, and the default levels may be lowered to increase the level of oversight and verification. TxDOT requires each project team to conduct a risk workshop with FHWA to evaluate any unique project-specific conditions. Based on the results of this workshop, the levels of analysis for each analysis category will be established for the project.

4.2.1 Level 1 — Continuous Analysis

Level 1 provides continuous analysis for those analysis categories that are strong indicators of performance. Examples include compressive strength for hydraulic cement concrete, percent soil compaction for embankment, and percent asphalt content for hot-mix asphalt concrete. The QA testing frequency is in compliance with the Guide Schedule, and the OV testing frequency should be a minimum of ten percent of the QA testing frequency. F- and t- tests are performed on these material categories on a continuous basis with the addition of each OV test result. The p-values (from the F- and t- tests) are reported for each analysis and tracked over time. This approach enables TxDOT to efficiently monitor the validation status of each analysis category daily and allows for more timely action to address non-validation.

When using the F- and t- tests for OV, the objective is to maximize the OV sample size (which should be smaller than the QA sample size) so as to have a sufficiently powerful analysis, while capping the maximum OV sample size so as to limit the detection of materially insignificant statistical differences. For example, there were statistical non-validation scenarios on SH 130 where both the OV and QA samples populations significantly exceeded the specification requirement and the difference in the means was smaller than TxDOT's split-sample tolerance for that test method. In the continuous analysis approach, the OV sample population increases as additional OV test results are reported, up to a maximum of 25 OV test results or a maximum time period of 90 days. In addition, the maximum number of OV test results was established to limit the detection of materially insignificant (from a material performance standpoint) statistical differences. The maximum time period of 90 days was also established to limit the inclusion of different sample populations into one analysis. For example, aggregate base from a given quarry may have different properties based on the location and depth from which material is being excavated. Not including a time limit on the time period for which test results are included in the F- and t- tests may lead to the inclusion of test results no longer representative (or from the same sample population) of the current production run.

At the end of each day, I2MS searches for any new OV test results approved that day and will automatically trigger a new analysis in that analysis category if it finds one. New OV tests are those test results considered to have been submitted for the first time, corrected or revised. Each continuous analysis is based on the following criteria:

1. If there are fewer than 25 OV test results in the past 90 days, the analysis will cover the past 90 days. All OV and QA samples in that date range are selected and used in the F- and t-tests.
2. If there are more than 25 OV test results in the past 90 days, the analysis will cover the date range from the date of the 25th most recent OV test result to the current date. All OV and QA samples in that date range are selected and used in the F- and t-tests.
3. If there are newly approved tests beyond the past 90 days, the analysis will cover the date range from that oldest unanalyzed test result to the current date. All OV and QA samples in that date range are selected and used in the F- and t-tests.

Figure 4.2-1 provides an illustration of the continuous analysis concept. A fictitious OV testing frequency that is higher than recommended is presented to fit the illustration into one figure. On Day 1, there are seven QA tests and four OV tests. When the results for Day 1 are approved, the Analysis 1 is performed and the p-values for F- and t- tests are reported. A p-value higher than the specified level of significance for that material category indicates that there is no statistically significant difference (i.e., the null hypothesis in

the F- and t- tests are accepted) between OV and QA test results. Conversely, a p-value lower than the specified level of significance for that material category indicates that there is a statistically significant difference (i.e., the null hypothesis in the F- or t- test is rejected) between OV and QA test results. On Day 2, there are three additional OV tests results and seven additional QA test results reported. Analysis 2 is performed with the cumulative number of 14 QA test results and 7 OV test results. The number of OV test results in each subsequent analysis continues to increase until Day 9, when the maximum number of 25 OV test results is exceeded. At that juncture, the first four OV test results and the first seven QA test results from Day 1 are excluded and Analysis 9 is performed on 25 OV test results (maximum number allowed) and 55 QA test results. The 55 QA test results are based on the QA tests performed in the same date range as the 25 OV tests. Similarly, on Day 110, there are test results that were reported more than 90 days ago. When the 90-day threshold is exceeded, those test results are excluded from Analysis 16. As a result, Analysis 16 is performed with 11 OV test results and 27 QA test results. As new OV test results are added to the analysis, older OV results are excluded. This method of data capture and analysis provides a “real time” view of the current status of validation on material from the same statistical population.

Figure 4.2-2 is a screen capture from I2MS dashboard for Level 1 analyses. In this I2MS user interface, TxDOT’s materials manager can monitor the status of validation for Level 1 analysis categories and record any action taken. Each line represents an analysis run for a given analysis category. Green numbers represent F- and t-test p-values for analyses where the OV test results validate the QA test results at the specified level of significance, and red numbers represent analyses that do not validate. Default levels of significance for each material category can be found in the TxDOT DB QAP. These levels of significance were developed based on practical experience using the SH 130 project data and are consistent with practices around the country.

The arrows to the left of the p-values indicate the trending of the moving F- and t- test analyses. Green upward arrows indicate a positive validation trend (increasing confidence in validation) and red downward arrows indicate a negative validation trend (decreasing confidence in validation). The number of arrows indicates how many times the analysis has moved in that direction, with a maximum of three arrows representing three or more movements in that direction. For example, a red number with one red downward arrow indicates that the material category is not validating and the last analysis indicated a decrease in the level of validation. I2MS enables TxDOT to evaluate these Level 1 tests practically in “real time” and take the necessary actions to proactively manage the project and minimize non-validation. The “details” button at the right of the screen allows TxDOT’s Materials Manager to record comments on the current analysis, view historical F- and t- test analysis results and comments, view a plot of the QA and OV tests results against the date of each test, and view specific test identification information (sample date, tested by, material code, etc.) for each test in the analysis.

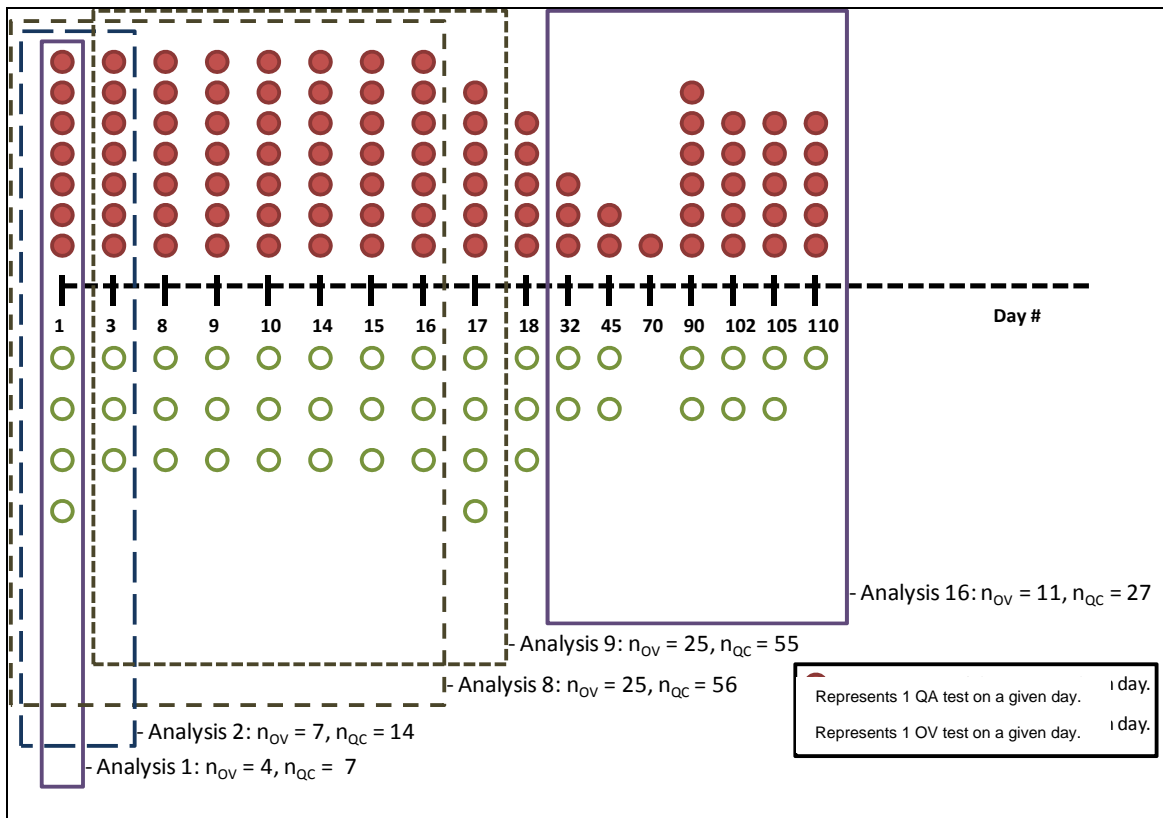


Figure 4.2-1: Example of Continuous Analysis Algorithm

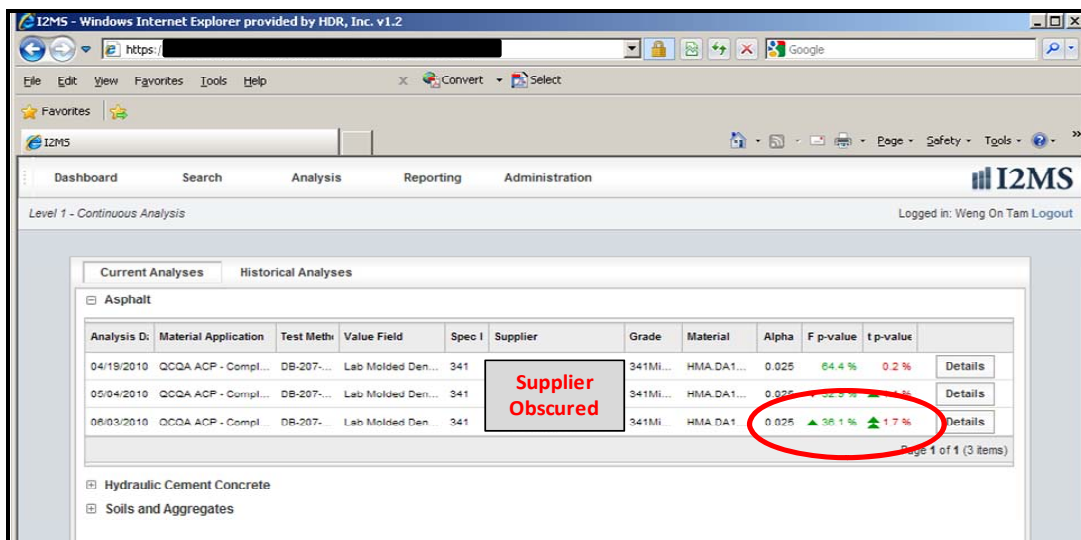


Figure 4.2-2: Screen Capture Showing Example I2MS Continuous Analyses Dashboard

For analyses that indicate validation and less than three downward trending arrows, each new analysis will be displayed for one day in the “current analysis” tab before automatically being moved to the “historical analysis” tab at the end of the day. For analyses that do not show validation or have three downward trending arrows, each analysis will require a comment from the Materials Manager (responsible for OV).

This comment is to acknowledge the trend and/or record any action taken to address the results of this analysis prior to it being moved to the “historical analyses” tab.

Figure 4.2-3 shows a report that can be generated to visualize the validation (p-value) trend for a given analysis category. This is an example of the Level 1 report for a concrete mix. A red line indicates that the F- and t- tests are performed at level of significance of 0.025 or 2.5 percent. The blue dashed trend line shows the p-value for the F-test, which has consistently been above the red line, indicating validation of the QA test results. The yellow solid line shows the p-value for the t-test, which has steadily increased from below the red line. This trend indicates that this analysis category is now validating, though it started out not validating. The obscured comments showed how TxDOT’s Materials Manager noticed the non-validation and took steps to address the issue. This is an example of how knowledge of the status of validation can help identify trends in non-validation in “real time” (rather than at the end of each quarter) and take necessary investigative steps to potentially avoid non-validation or bring the analysis category into validation more quickly.

4.2.2 Level 2 — Independent Verification

Level 2 provides independent verification for those materials that are secondary indicators of performance. An example is the slump test for hydraulic cement concrete. The QA testing frequency is required to be in compliance with the Guide Schedule, and the OV testing frequency should be a minimum of once per quarter. Figure 4.2-4 provides a Level 2 analyses screen capture from the I2MS dashboard. Using this I2MS user interface, TxDOT’s Materials Manager can monitor the status of verification for Level 2 analysis categories and record any action taken.

The “details” button at the right of the screen allows TxDOT’s Materials Manager to record comments on the current analysis, view historical independent verification results and comments, view a plot of the QA and OV tests results against the date of each test, and view specific test identification information (sample date, tested by, material code, etc.) for each test in the analysis. Each independent verification analysis category will appear on the “current analysis” tab when the first QA test result in that category is approved for analysis. Each analysis category that appears on the “current analysis” tab will remain on that tab until a review of the QA and OV test results is performed and TxDOT’s Materials Manager determines if the QA test results are “verified” or “not verified” by the OV test results. TxDOT’s Materials Manager is responsible for addressing any analysis that results in a “not verified” status. When the analysis is addressed, it will be moved from the “current analyses” tab to the “historical analyses” tab.

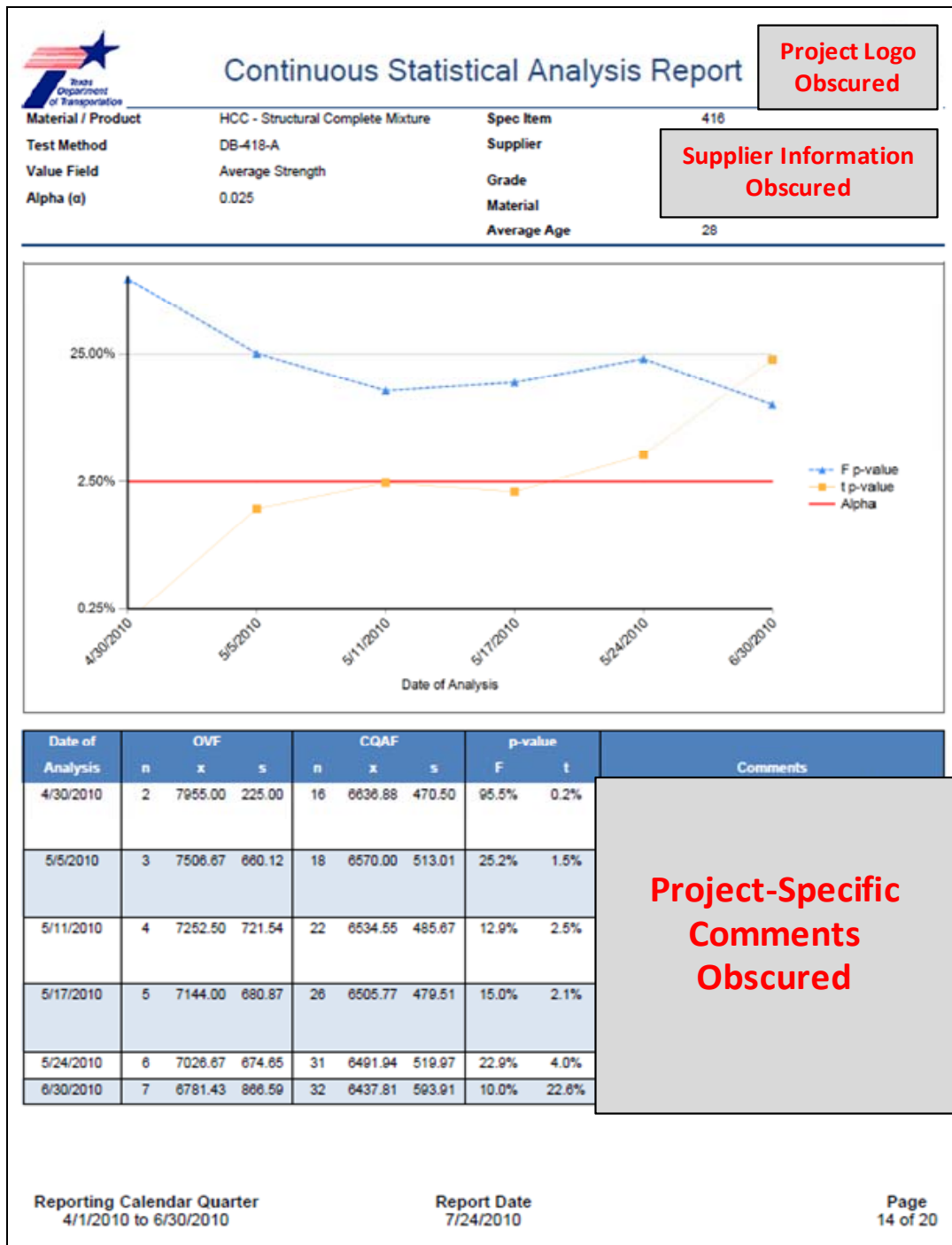


Figure 4.2-3: Screen Capture of I2MS Sample Continuous Analysis Report

The screenshot shows the I2MS web application interface. At the top, there are navigation tabs for Dashboard, Search, Analysis, Reporting, and Administration. The main content area is titled 'Level 2 - Independent Verification' and includes a search bar and a table of analysis results. The table has the following columns: Date Verifi, Material Application, Test Meth, Value Field, Spec It, Supplier, Grade, Material, Status, nCQA, nOV, and Details. Three rows of data are visible, all for 'Asphalt' material. A red box with the text 'Supplier Obscured' is overlaid on the 'Supplier' column of the first two rows.

Date Verifi	Material Application	Test Meth	Value Field	Spec It	Supplier	Grade	Material	Status	nCQA	nOV	Details
07/02/20...	CCQA ACP - Complete...	DB-200-F	Cumulative Percent...	341	Supplier Obscured	341Mix...	HMA-DA1B11...	Veri...	32	8	Details
08/28/20...	CCQA ACP - Complete...	DB-200-F	Cumulative Percent...	341	Supplier Obscured	341Mix...	HMA-DA1B11...	Veri...	336	32	Details
08/28/20...	CCQA ACP - Complete...	DB-200-F	Cumulative Percent...	341	Supplier Obscured	341Mix...	HMA-DA1C19...	Veri...	49	14	Details

Figure 4.2-4: Screen Capture of I2MS Independent Verification Dashboard

Figure 4.2-5 shows a report that can be generated to graphically represent QA and OV data trends and show the comments recorded by TxDOT's Materials Manager. This figure represents an example of the Level 2 report for the hydraulic cement slump of a concrete mix. The obscured comments show TxDOT's Materials Manager's comments that justified the decision that the OV test results verified the QA test results.

Level 2 verification is based on the application of engineering judgment to determine whether the QA and OV test results represent the same material.

4.2.3 Level 3 — Observation Verification

Level 3 provides observation verification for those materials that require only a very few QA tests for compliance with the Guide Schedule or tests on materials where risk of failure does not affect the long-term performance of the facility past the contractual maintenance obligations. For example, the acid insoluble test (Tex-612-J) for fine aggregate in hydraulic cement for concrete pavements has a frequency of once per project per source. Another example is the entrained air test (Tex-416-A) for non-structural (miscellaneous) concrete riprap, where risk of failure does not affect the long-term performance of the facility past the contractual maintenance obligations. Under the Level 3 approach, OV does not perform tests but observes the QC test performance for equipment and procedural compliance with the test procedure. The frequency

of this testing is a minimum of once per project per test method or periodically as determined by TxDOT's Materials Manager. For Level 3, the OV representative observing the QA technician performing the test enters his observation findings into I2MS for recordkeeping purposes.

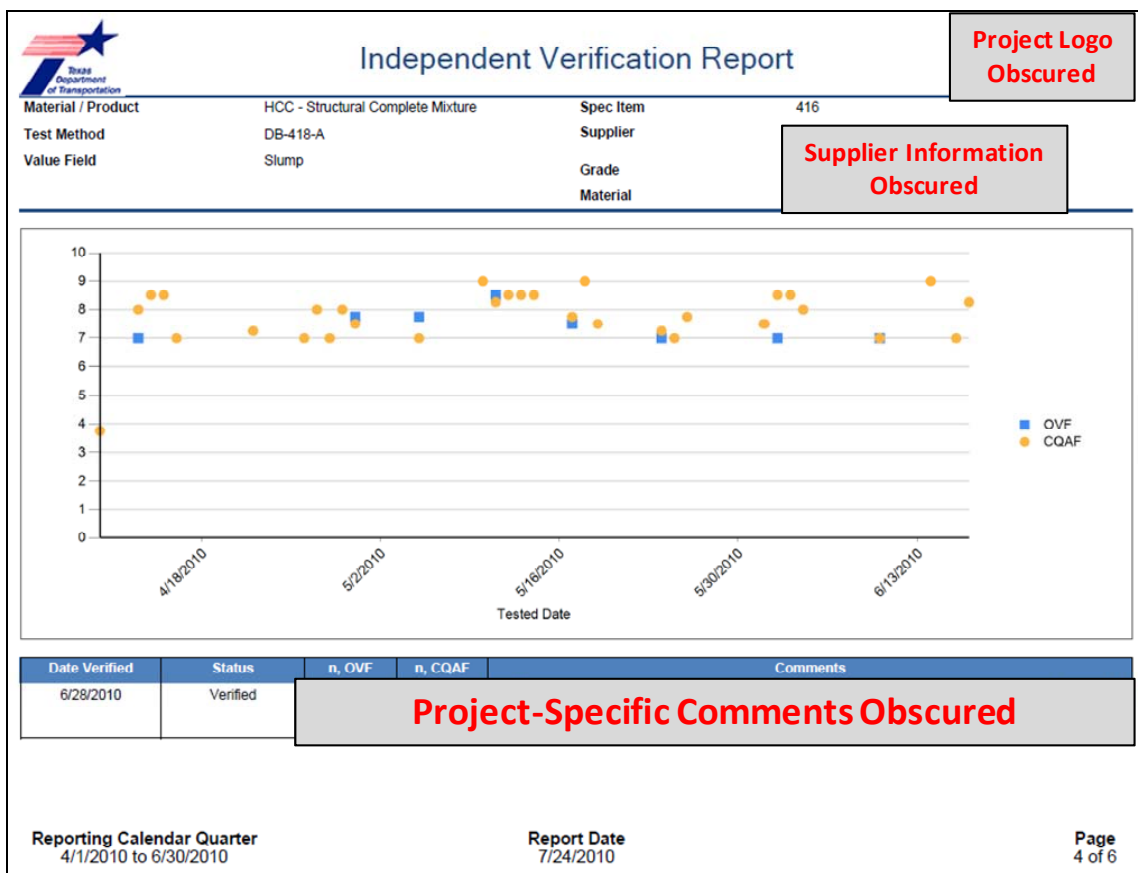


Figure 4.2-5: Screen Capture of I2MS Independent Verification Report

Figure 4.2-6 is a screen capture from I2MS dashboard for Level 3 observations. Using this I2MS user interface, TxDOT's Materials Manager can monitor recorded observations of the QA test performance. The "comment" button at the right of the screen allows TxDOT's Materials Manager to record comments on the current observation. Each observation category will appear on the "current observation" tab when the first QA test result in that category is approved. Each analysis category on the "current observation" tab will remain on that tab until an observation is recorded. When the observation is recorded, it will be moved from the "current observation" tab to the "historical observation" tab.

Test Method	Value Field	Date Observed	Observed By	Comments
DB-418-A	Concrete Temperature	06/26/2010	Names Obscured	1 Comment
DB-418-A	Concrete Temperature	06/14/2010		1 Comment
DB-114-E	Max Density (kg)	06/12/2010		1 Comment
DB-114-E	Optimum Moisture	06/12/2010		1 Comment
DB-418-A	Concrete Temperature	06/02/2010		1 Comment
DB-418-A	Concrete Temperature	05/24/2010		1 Comment
DB-418-A	Concrete Temperature	05/24/2010		1 Comment
DB-114-E	Max Density (kg)	05/19/2010		1 Comment
DB-114-E	Optimum Moisture	05/19/2010		1 Comment
DB-113-E	Max Density (pcf)	05/13/2010		1 Comment
DB-113-E	Optimum Moisture	05/13/2010		1 Comment
DB-113-E	Max Density (pcf)	05/10/2010		1 Comment
DB-113-E	Optimum Moisture	05/10/2010		1 Comment
DB-418-A	Concrete Temperature	06/08/2010		1 Comment
DB-113-E	Max Density (pcf)	05/08/2010		1 Comment
DB-113-E	Optimum Moisture	05/08/2010		1 Comment
DB-113-E	Max Density (pcf)	05/01/2010		1 Comment
DB-113-E	Optimum Moisture	05/01/2010		1 Comment
DB-113-E	Max Density (pcf)	04/28/2010		1 Comment
DB-113-E	Optimum Moisture	04/28/2010		1 Comment

Figure 4.2-6: Screen Capture of I2MS Observation Verification Dashboard

4.3 FHWA Quarterly Reporting

The DB QAP requires that a report be produced and submitted to the FHWA Division Office for concurrence describing TxDOT's efforts to comply with the QA commitments for each material incorporated into the project. The reporting period for specific materials is dependent on the pace of construction and the number of tests performed in each analysis category, the time period of the sampling, and the specification and quality requirements. Approved reports will be distributed to the CQAF after receiving FHWA concurrence. An example of an FHWA Quarterly Report may be obtained from TxDOT CST/M&P.

Each report covers a period of construction not greater than three months and addresses the following areas. Project-specific conditions may warrant other information to be included in the report or the format of the report to be slightly modified. All questions concerning the content and format of the report should be addressed to TxDOT CST/M&P prior to writing the report.

1. Transmittal letter;

2. Summary of findings for each material category and major findings for non-validation investigations;
3. Statistical analysis results, to include specification requirements and status of the validation process during start-up and completion of an item;
4. Non-validation investigation;
5. Non-Conformance Log;
6. Engineering Judgment Log; and
7. Construction certification.

4.4 Inspection Oversight

4.4.1 General

Inspection of the construction materials and the performance of the work, by both the Developer's QC personnel and the Developer's QA personnel, are critical to the delivery of a quality product meeting the project specifications. As part of the implementation of the Developer's CQMP, the Developer has made commitments for the inspection requirements for various construction items of the project. In general, the role of construction inspection oversight is to monitor, in a timely manner, the performance of inspection commitments of the Developer's inspection team. Section 3.4.2 of the DB QAP provides an outline of the inspection requirements for OV.

TxDOT's commitments to the oversight of construction inspection are documented in the OVTIP for the project. The plan should include oversight activities and also include how TxDOT personnel will interact with corresponding QC and QA personnel. Although the OVTIP requires periodic OV inspection of construction to verify the QA's quality of inspection, the responsibility for acceptance inspection resides, for work performed on-site, with the QA personnel. The successful use of the QA/OV model requires the QA to provide inspection with OV performing the oversight necessary. The best way to develop that confidence is for the OV personnel to engage with the QA personnel on a regular basis to develop a pattern of communication and provide support as needed.

4.4.2 Requirements for Construction Inspection Oversight

The requirements for construction inspection oversight are documented by the OV team in the OVTIP. The OVTIP includes a compilation of all of the inspection and testing procedures identified for the project. Inspection procedures and personnel roles are detailed in Section 3.6. TxDOT or its designee will employ a staff of oversight inspectors to perform the OV inspections. The following are typical inspection roles for a DB highway construction project:

1. Earthwork Inspector: oversees the CQAF inspection of earthwork activities, including the operations required for preparation of right-of way; demolition of existing structures; excavation of roadway; preparation of subgrade; and compaction of embankment, subbase, and base materials;
2. Pavement Inspector: oversees the CQAF inspection of hot mix asphalt concrete and hydraulic cement pavement placement;
3. Structural Inspector: oversees the CQAF inspections of the various structural elements of the project including, but not limited to the structural excavations, drilled piers, concrete bridge elements, structural steel construction, retaining walls, and concrete culverts;

4. Utility Inspector: oversees the CQAF inspections of the utility construction and relocations;
5. Environmental Inspector: oversees the CQAF inspections of the erosion control measures, including Storm Water Pollution Prevention Plan (SW3P) measures, and the re-establishment of ground cover; and
6. Toll Facility Inspector: oversees the CQAF inspection of the construction of the toll facilities.

Depending on the size of the project, there may be multiple categories of inspectors, or an inspector may be required to fulfill more than one role. The intent is not to duplicate inspection of the work provided by QA team but to verify the performance and documentation of the QA inspections. Not only will the OV team be overseeing a much larger QA inspection team, but if the QA team perceives the OV team as performing duplicate inspections, it may detrimentally influence their own inspections by simply letting the OV inspectors perform the inspections. The responsibility for inspection of the work for acceptance and the risk associated must remain with the QA team; however, the QAP does require TxDOT to provide a procedure to perform oversight inspections for all QC and QA inspectors. A set frequency of oversight inspections is not specifically required. The oversight of a particular inspector should be performed early in the construction process to identify any concerns, whether it is the manner of inspection or the documentation. Once confidence in an inspector is obtained, less vigorous oversight inspection of that inspector may not be required unless inspection responsibilities change or a concern is identified. Although the OV team may not be making acceptance inspections, an experienced inspector will know what to look for and will still be making assessments on the quality of the work. It is by this method of performing oversight inspections of the inspectors, performing their own observation of the work and verifying the required inspections are performed and documented, that the OV team confirms the QA inspection requirements are met.

4.4.3 Training

Each of the OV inspectors must have experience in inspection of the work they are overseeing; however, because certification of inspection is only required for the inspection of hot mix paving, the inspectors will not be required to have specific certifications for their roles. Also each project is different in some way and may have elements that individual inspectors are not familiar with. This may require the OV team to provide training for their inspectors through specialized training and/or access to relevant training material. The OV manager reviewing inspection reports is also responsible for verifying that the OV inspector is competent in the areas of inspections. If the OV manager becomes aware of an area of concern, it is his/her responsibility to see that the inspector is provided with the proper training and resources.

4.4.4 Management Process for Construction Inspection Oversight

4.4.4.1 Responsibility of OVF Inspection

TxDOT has a hierarchy of responsibility with regard to the performance of oversight inspection work. The QAP, however, does not prescribe the structure of the OV operations. It is the requisite of TxDOT, or its designee, to develop its organizational structure to match its responsibilities and methods that are then presented in the OVTIP. The structure, however, must address the need to provide timely information to field inspectors regarding the daily and near-term schedules, the latest released for construction drawings, and the resolution of any current issues. Likewise, the flow of information must also travel back up the hierarchy so that issues that need resolution are recognized as needing action in a timely fashion.

4.4.4.2 Notification

The QAP requires the Developer to provide information to the OV team regarding the schedule by providing a three week schedule of the anticipated work activities, with a daily update of any changes. In addition, the Developer will inform TxDOT when materials are ready for sampling and testing and of any hold points. Hydraulic concrete placements will require particular notification measures. Structural concrete placements involve both timely inspection and material testing and will be of particular concern to the QA and OV teams. One method of notification employed has been the preparation of a daily schedule of the concrete placements that is emailed to a list of agreed recipients. For larger projects, this list may need to be updated one or more times during the day as changes are made. If the notifications are only provided at a higher level to TxDOT, then dissemination of the notifications to the OV oversight inspectors needs to be addressed as a daily operational practice. In an effort to minimize miscommunications, the parties may choose to formalize how the daily notifications are provided to the OV team, such as daily updates and hold points given at an operational level. This may allow the OV team to respond to these more quickly.

It is expected that the OV oversight inspectors will have a general idea of the daily activities to be performed within their area of interest by being actively engaged with the Developer's personnel. Although the responsibility for notification rests upon the Developer, for their part, TxDOT personnel cannot be passive and need to both anticipate the daily work activities and ask the Developer's personnel for any updates. The OV oversight inspectors themselves may also need to inform the OV testing technicians of the need for sampling and testing. Although they will typically have their own means of notification, the OV oversight inspectors can serve as an important secondary notification system.

4.4.4.3 Delegation

The structure of the OV oversight inspection team should be clear enough that on any given day, an inspector will be able to determine the general activities for which he is responsible to provide oversight inspection; however, there will be activities that TxDOT or the OV team identify as being of particular importance and requiring special attention. This may occur when the Developer is just starting an operation or when a particular risk is identified. The OV manager should notify the respective OV oversight inspector not only of the activity but also of any particular concerns.

This may require a meeting of respective OV personnel prior to a pre-activity meeting to review the operation and verify that the concerns are covered in the pre-activity meeting and during construction. If a particular risk has been identified, the OVF supervisor will want to address it with the inspector. This may also include meeting with subject experts within the team to help disseminate information as well as to provide relevant design and construction material.

4.4.4.4 Dispute Resolution

Dispute resolution of inspection work items can be challenging. Although some items are easily discernable, such as the size and spacing of reinforcing steel, other materials require a judgment to be made. This is particularly true of non-homogenous materials, such as proper processing and compaction of soil embankment.

In an effort to be as efficient and timely as possible, it is recommended that the Developer, QA team, and OV team develop a plan to resolve disputes as near to the operational level as possible. One method is to use an issue escalation matrix to identify personnel within each organization that roughly mirror one

another's responsibilities in ascending levels of responsibility. In this way, if a dispute arises that cannot be resolved in the field, the next level of responsible parties can be identified to address the dispute. The pattern repeats itself until an agreement can be made. Time limits can be established for how long an agreement can be worked out at a particular level before it should be addressed at the next level. Time critical disputes may, however, ascend to the highest level within a day.

4.4.5 Compliance of QC, QA, and OV Commitments

The Developer, QA, and OV have all made commitments that need to be met on a continuous basis for the delivery of acceptable work and to minimize delays and rework. The work always starts with the Developer, and its commitments first need to be verified. The QA team needs to verify that the QC inspection has first been performed and documented before QA inspection starts. Whenever a QA inspection occurs, there should be a corresponding QC inspection report that can be identified during an audit to verify the completion of the Developer's QC inspection requirements as required by the CQMP. When there is a breakdown in the Developer's inspection duties with regard to not only completing and documenting their inspection but also in the performance of an acceptable level of inspection, then delays caused by rework and re-inspection are typically the result. When a pattern of rework and re-inspection is identified, then the issue of an acceptable level and completion of QC inspection needs to be brought forward from the operational level to determine the cause. This may result in an audit of the Developer's records and methods to find if it is the result of substandard inspections, inadequate inspection procedures, a lack of training, the most current plans not being provided, or some other breakdown. The findings of the audit then need to be evaluated by the Developer and corrective measures implemented. These corrective measures should be verified by the QA and OV teams. The OV personnel need to verify that the QA inspectors review the QC inspection reports as required by the CQMP. This includes using the approved forms and procedures designated in the CQMP.

The QAP has a requirement for the QA to transmit their inspection reports to TxDOT within 24 hours after the work shift has ended. Although there is no requirement for the OV oversight inspectors to review every QA inspection report, there is a responsibility to periodically review them for fulfilling the requirements of the CQMP. In addition, audits are typically performed to see that the entire inspection process has been completed, from the initial review of the QC inspection, to the field inspection itself, to the review of the report in a timely manner. In addition to monitoring the reports, one of the responsibilities of the OV inspection team will be to monitor the QA team's ability to inspect all of the work. The Developer's work needs to be inspected before it is accepted and material placed on top of it. This may require full time inspection for some work such as embankment, back fill of mechanically-stabilized earth retaining walls, and utility trenches. Likewise, concrete placements may require full time inspection. If the QA team is unable to perform all the required inspection work, then corrective measures should be implemented. It may require the Developer to alter the work plan or for the QA team to hire additional staff if the existing QA team cannot cover the ongoing activities.

The OV oversight inspection role is principally one of oversight. The goal is to provide the support and "encouragement" so that everyone is fulfilling their respective responsibilities for inspection. While the initial oversight intensity may be higher to establish confidence in the QA inspection work, it is likely that the system will reach a happy equilibrium once the QC and QA personnel are comfortable performing their roles and expectations are been reconciled. In this sense, at least, the measure of the OV oversight inspection fulfilling its responsibilities is really determined by how effective it is in "enabling" the QC and QA teams to fulfill their respective responsibilities. If insufficient progress is being seen in getting everyone to

meet their requirements without constant intervention, then the OV team will need to examine its approach to see if it can identify how to improve compliance with the CQMP and OVTIP.

4.5 Dispute Resolution

4.5.1 Non-Validation, Non-Conformance, and Material Quality

Guidance is provided in the DB QAP on conducting non-validation investigations. If the OV test results do not validate the QA test results, a joint investigation involving both TxDOT and the Developer is conducted to determine the reason for not validating. Areas to be investigated include:

1. Establishment of analyses categories,
2. Data integrity and accuracy, and
3. Testing equipment and procedures.

The first area mentioned above is the rules in which the analysis categories were established. Typically, the analysis categories are established in a manner to appropriately segregate different materials and operations. At the same time, it is also important to have sufficiently large sample populations in each Level 1 analysis category for an effective analysis.

Data integrity and accuracy refers to the integrity of the data entered into the system. Test results have been broken out into separate groups for analysis based on the type of materials, source of materials, processing methodology, and other applicable differences in the material. The appropriate CVLs need to be assigned to each test result to ensure they are analyzed in the correct grouping. Errors in the labeling of test results can lead to incorrect validation conclusions. For example, an analysis category may not be in validation because tests results were incorrectly added or excluded from the analyses. Therefore, non-validating analysis categories should be reviewed to check that only the correct test results were included in the analyses. Additional sources of incorrect analyses may also be due to, but are not limited to:

- Errors in sampling and testing,
- Faulty equipment or equipment that is out of calibration, or
- Technical performance.

The evaluation of test equipment and personnel may be conducted separately or evaluated together through the performance of split samples. Split samples may be performed to investigate non-validating material categories and to verify or realign testing equipment and personnel. The DB QAP requires the results of non-validation investigations to be reported as described below.

In addition to statistical non-validation, the DB QAP requires an immediate investigation for individual failing test results to determine if material can be left in place or has to be removed. Procedures for determining the status of material quality requires the direct comparison of QA and OV results. How these values compare to specification limits will determine the appropriate course of action. The appropriate party (QA or OV) may exercise engineering judgment to determine that the material will perform its intended purpose for their respective tests. There are four possible combinations of passing and failing results between the QA and OV test results.

1. Both the QA and OV test results pass specification limits: Although statistical validation has not occurred, both the QA and OV test results are passing the established specification limits; thus, material quality in question is considered acceptable.
2. QA test results fail and OV test results pass specification limits: Material may be left in place if the CQAF determines that engineering judgment may be used to accept the material or if the material is accepted through the NCR process.
3. Both the QA and OV test results fail the specification limits: Material may be left in place if the CQAF determines that engineering judgment may be used to accept the material or if the material is accepted through the NCR process. The acceptance of material is subject to one of the two scenarios below.
 - a. OV test result indicates reasonable conformance with specification requirements, and TxDOT exercises engineering judgment to concur with acceptance of material based on the CQAF's engineering judgment or through the NCR process.
 - b. OV test result does not indicate reasonable conformance with specification requirement, and the CQAF must perform an additional fixed test at the OV failed test location. Based on the results of CQAF test result and subsequent investigation discussions between TxDOT and the Developer, a determination is made and documented on whether the material may be left in place.
4. QA test results pass but OV test results fail specification limits: Material may be left in place if the CQAF determines that engineering judgment may be used to accept the material or if the material is accepted through the NCR process. This is subject to TxDOT response in the two scenarios below.
 - a. OV test result indicates reasonable conformance with specification requirements, and TxDOT exercises engineering judgment to concur with acceptance of material based on the CQAF's engineering judgment or through the NCR process.
 - b. OV test result does not indicate reasonable conformance with specification requirement, and the CQAF must perform an additional fixed test at the OV failed test location. Based on the results of CQAF test result and subsequent investigation discussions between TxDOT and the Developer, a determination is made and documented on whether the material may be left in place.

4.5.2 Engineering Judgment

The DB QAP allows the CQAM to exercise engineering judgment to accept materials that do not meet minimum specification limits but indicate reasonable conformance for their intended use. The use of engineering judgment must be documented and supported by sound engineering reasoning. The CQAM generates a log of engineering decisions, which is provided to TxDOT on a monthly basis.

Some materials that do not meet minimum specification limits but are adequate for their intended use may require the review and approval of the design engineer before they are incorporated into the project. Documentation through an NCR process is required in these instances, with an NCR log generated by the CQAM.

4.5.3 Referee Process

Disputes over specific test results may be resolved in a reliable, unbiased manner by referee testing and evaluation performed by a referee laboratory. TxDOT CST or a qualified testing laboratory approved by TxDOT will be the referee laboratory. The decision by the referee laboratory will be final.

4.6 Compliance Audits

The goal of audits is to verify that project procedures and commitments are performed appropriately to ensure the quality of the project. TxDOT will audit the Developer compliance with the CQMP. While overall oversight entails a general review of all of the Developer's work, audits are a targeted and detailed review of a few specific aspects of the CQMP. Initial audits are recommended shortly after the start-up phase of the project to verify that the Developer's operations are starting out in the agreed-upon direction. These audits may cover areas such as materials testing and reporting, inspection performance and reporting, quantity tracking, non-conformance report resolution, and engineering judgment resolution. These initial audits allow TxDOT to build confidence in the Developer's operations and provide feedback on areas of concern as may be appropriate before too much work has already been performed. Additional audits are performed periodically over the duration of the project to verify compliance on a regular basis or to investigate specific areas of concern.

There are two types of audits: scheduled and unscheduled. Scheduled audits are planned and scheduled in advance with the Developer to help ensure availability of the key Developer staff involved in the areas of work being audited. This advanced notification also allows for audit materials to be ready for easy access during the audit and is especially useful for audits on material that may be located at several locations. Unscheduled audits are similar to scheduled audits except that limited advanced notification is provided to the Developer. In general, most audits are scheduled, with unscheduled audits employed when appropriate and necessary.

In addition to auditing the Developer, TxDOT should also audit its own operations periodically to see if the OV work is being performed in accordance with the OVTIP. The OV work is an integral part of the acceptance program and works hand-in-hand with the Developer-performed acceptance work. The Developer's acceptance work may only be used when verified by the OV work.

4.6.1 Developer Audits

The process of performing an audit can generally be divided into eight steps.

1. Audit Preparation,
2. Audit Announcement,
3. Pre-Audit Meeting,
4. Audit,
5. Preparation for Audit Debriefing Meeting,
6. Audit Debriefing Meeting,
7. Audit Report, and
8. Audit Close Out.

The first step in auditing is the preparation for the audit. This process starts with the determination of which areas should be audited. One should not try to audit every area of ongoing work at one time, but rather break it up into several meaningfully-sized audits. Remember that an audit is not meant to be an exhaustive and detailed review of all the Developer's work. Once the areas of work are determined, the appropriate auditors should be assigned and a lead auditor selected. The lead auditor will serve as the primary point of

contact between TxDOT and the Developer's designated point of contact for the audit. Both parties should identify a suitable time and duration for the audit, as well as the required Developer personnel that will need to participate. Once the scope and timing are confirmed, a formal announcement containing details of the upcoming audit should be formally transmitted to the Developer.

On the day of the audit, a pre-audit meeting should be conducted with the key personnel involved. This should include the auditors and Developer personnel involved in the audit process. During this meeting, each audit participant should review the audit schedule and clarify expectations for each area to be audited. For example, the audit may cover all material testing performed within a given date range. Questions should be addressed prior to beginning the audit to the extent possible. Any questions that arise after the audit has begun should be brought to the lead auditor's attention to be addressed.

During the audit, auditors will work with their Developer counterparts to witness procedures and review documents related to the audit. This may include a visual review of the performance of quality procedures in the field or review of the quality documentation procedures. It may also include the review of quality documentation of the quality processes. Each step of the audit should be documented for compliance or non-compliance with quality procedures. When there is uncertainty as to whether there is compliance with the quality procedures, auditors should seek clarification from their Developer counterparts and request supporting documentation. To the extent possible, documentation of compliance or non-compliance should be made during this timeframe of the audit. Auditors are encouraged to make copies of documents to substantiate their findings and include them in the audit report. When it is not possible due to reasons beyond the auditor's control, the auditor may request that a process or procedure be reviewed at an agreed-upon time outside the original audit timeframe or that the documentation for a given process be provided after the audit debriefing meeting. Post-audit debriefing activities should be discussed and agreed upon with the lead auditor. An example would be the audit of an area of work subject to an outstanding non-conformance report. The disposition of the work may be decided after the conclusion of the audit, but the information may still be included in the audit report if it is resolved prior to that time.

At the conclusion of the planned audit activities, the lead auditor should meet with the other auditors to discuss their preliminary findings. This will include areas of compliance or non-compliance, areas of concern, additional audit activities recommended for after the planned audit schedule, and other miscellaneous issues arising from the audit. The auditors should come to a consensus on the overall level of compliance and prepare to debrief their Developer counterparts. At the audit debriefing meeting, the auditors will provide an overview of the preliminary findings and provide an opportunity for additional questions and clarifications. Any critical areas of concern should be communicated immediately. The group should then agree on follow-up activities, as may be necessary, and agree on a timeline to provide a formal audit report.

While all the auditors will work as a team to complete the audit report, each individual auditor is responsible for writing the portion of the report related to the area he or she audited. Individual auditors are also responsible for providing the lead auditor documentation to support their findings. Each section should describe the scope of the each area of audit, specific factual findings, and specific description on the compliance or non-compliance with the applicable CQMP procedures. The lead auditor is responsible for compiling each section of the audit findings and completing the introduction and conclusion sections. Once the draft report is compiled, the team should review the report and make any necessary changes to the final version to be transmitted to the Developer. Attachment L provides an example audit report.

After the Developer has had time to review and understand the audit report, a meeting between TxDOT and the Developer is recommended to discuss the audit findings and any actions that the Developer will take to address the areas identified as non-compliant. Following an agreement on the path forward, the Developer will submit a formal response to the audit documenting remedial actions to bring their operations into compliance with the quality procedures. This may include modifications to established procedures and the development of new procedures to address areas of non-compliance.

The audit team should follow up on the remedial action to verify that the remedial measures address the non-compliance and are being effectively implemented. This review may include follow-up observations of procedures or review of new documents. Once the efficacies of the remedial measures are verified, the audit team should then issue a follow-up report to close out the original outstanding items. Depending on the outcome of the follow-up audit, additional remedial action and a further verification effort may be necessary to close out outstanding items.

4.6.2 TxDOT Internal Audits

Similar to the Developer audits, TxDOT internal audits are used to check compliance with OV procedures. Areas to audit may include OV sampling and testing procedures, OV testing frequency, and timeliness and sufficiency of non-validation investigations. The process outlined in Section 4.6.1 can generally be used for TxDOT internal audits, except that the auditors would be members of the local management team or TxDOT CST may audit the OV staff for compliance with the OVTIP.

4.7 Section Summary

Previous sections have established the framework to establish the DB QAP. This section discussed the arduous task of Project Operations. The major concept of the DB QAP is that the Developer's test results are used as part of the acceptance decision and must be verified through the use of Owner Verification. Implementation of this concept requires that independent sampling and testing occur between the QA and OV staff and that validation procedures be implemented. This section discussed these validation procedures and established the reporting requirements in the form of the FHWA Quarterly Report.

Inspection oversight by TxDOT, or its designee, was also discussed. The OVTIP manual is used to perform oversight inspection and provides the tools necessary to document the CQAF's acceptance of Developer-performed construction.

The process of Dispute Resolution was discussed in Section 4.5. Key concepts included the process of resolving non-validation, non-conformance, and material quality related issues. When OV test results do not validate QA test results, joint investigations occur to determine the reason for non-validation. Materials that are in reasonable conformance but do not meet specification requirements can be deemed acceptable for incorporation into the project but must be accepted through the use of Engineering Judgment or through the NCR process. Lastly, questions concerning material quality must be addressed immediately, irrespective of statistical validation efforts, to determine if the material can be left in place, reworked, or has to be removed.

The final topic discussed in this section concerned Compliance Audits. Various audits will need to occur during Project Operations to verify both the Developer's and Owner's commitments established in the CQMP and OVTIP, respectively. Audits generally consist of reviewing materials testing and reporting,

inspection performance and reporting, quantity tracking, and the process of acceptance and verification. Audits can be scheduled or unscheduled and include meeting to discuss report findings. Remedial measures and actions are provided, and the audit team will provide follow-up reviews to verify remedial steps were implemented properly and issue any final audit reports.

At this point in the implementation process, project staff should be:

1. Monitoring construction inspection and testing efforts.
2. Verifying compliance of the Developer's commitments in terms of QC and QA operations.
3. Conducting OV validation of materials testing results and documenting findings in the FHWA Quarterly Report.
4. Providing timely dispute resolutions.
5. Performing compliance audits and issuing findings for corrective actions.

5 Project Close-Out

The closeout process requires planning from the beginning to expedite properly. Planning must be done at the beginning to make sure that all of the required records will be obtained during the course of construction, will be accessible during closeout, and will be in a form that can easily be transferred. Although the scope of this guide focuses on the testing and inspection side, the project will generate other documents that will also require securing as part of the final closeout delivery to the owner. The project's development agreement will include provisions for the collection of these documents and final transfer to the owner. There are also two required documents that will be required to close out the project: the Final Statistical Analysis Report and the Material Certification for the project.

5.1 Final Statistical Analysis Report

The final Statistical Analysis Report will be similar in most respects to the previous statistical analysis reports, as it will typically include the analysis of material testing since the last report to the end of validation testing. The difference, in this case, will be in the requirements for materials that are not validated by OV test results, not only in the current time period, but also for material testing categories that were not previously validated by OV testing. This may include material categories that fluctuated in and out of validation. For these categories that have been identified in previous reports, the report will provide an analysis of the category to show the time period(s) the material represented by the category was not validated at some point by the accepted rules for providing validation. The amount of material placed during that time period is determined from the construction records and is presented in the discussion. The report will then provide an analysis for justifying the use of OV tests for the acceptance of the material category and a statement that TxDOT accepts the material.

If the Statistical Analysis Report has also been used to present the Engineering Judgment Log and the Non-Conformance Log, then the latest logs also need to be included with the final dispositions of the materials represented by the tests. The Engineering Judgment Log is a summary of the disposition of material accepted based on the allowed discretion of the Engineer although a failing test was recorded. The Non-Conformance Log is a summary of the disposition of materials represented by failing test results. Typically, this may be material accepted based on additional tests, such as a 28-day compressive strength test for a failing slump, or acceptance of the material by the Engineer of Record, perhaps with some remedial action. If it is not accepted, then a disposition of the removal and replacement of the material is documented. By including these logs with the periodic statistical analysis reports, the FHWA is able to be informed of the decisions being made for these materials and provide input as the project progresses.

5.2 Materials Certification

Attachment E provides an example of the Monthly and Final Materials Certification Letters that are submitted by the CQAM and TxDOT, respectively. The monthly letter is included with the statistical analysis reports for review by FHWA representatives. The CQAM will develop the material certification letter that includes a list of exceptions for all materials that fail acceptance tests but are in reasonable conformance with the plans and specifications and thus are incorporated into the project.

The Final Material Certification is developed by TxDOT and submitted to FHWA for acceptance. This letter references the FHWA Quarterly Reports as the documentation for both the acceptance of materials through

statistical validation and certification of monthly materials with exceptions. The final letter also certifies that both the QA and OV programs were evaluated by the Independent Assurance program.

5.3 Release of Records

The process of TxDOT providing Final Acceptance for a project includes providing a list of required documents from all of the parties for documentation. These typical requirements, such as the as-built drawings and the design documents, will be required in accordance with the language of the CDA for the project. In addition, the CQAF's acceptance tests that have not been previously transmitted for statistical validation, such as those only requiring observation verification, will need to be transmitted to the owner.

5.4 Section Summary

Although this section of the Implementation Guide is short, the process of properly closing out a project is important. Preparing for project close-out begins with early planning. Documents generated during the project will need to be secured and transferred to TxDOT. The Final Statistical Analysis Report and the Final Materials Certification Letter are required to close-out the project and to gain FHWA final approval, if federal participating funds are used.

It is important to realize that material categories not validated by OV during the final quarter of testing will require acceptance dispositions by TxDOT. The use of OV tests for acceptance of the material category and a statement of TxDOT acceptance will be required. Therefore, increased OV testing may be required so that sufficient data is present for those non-validating material categories. Additionally, the final Materials Certification Letter will need to be developed by TxDOT.

The last section of this guide provides examples and frequently asked questions to further clarify how to implement the DB QAP on projects.

6 Examples and FAQs

This section includes examples that have been encountered on previous design-build projects with recommended solutions, along with frequently asked questions (FAQs) pertaining to the DB QAP Implementation process. Since each project is unique, the solutions presented below provide a general explanation on how the problem was solved on a previous project in conformance with the DB QAP processes and procedures. It is recommended that project team members discuss each problem to find the optimal solution that best meets the needs of the project yet is in conformance with the project Contract documents. The sections below are organized with the subsection numbers corresponding to Sections 1 through 5 of this guide. For example, Section 6.1 includes problems and FAQs pertaining to Section 1 of the guide, Section 6.2 for Section 2 of the guide, so on.

6.1 Section 1 Examples and FAQs

6.1.1 Applicability of DB QAP procedures to concession CDAs

Question: Are the verification process and procedures contained in this guide applicable to Concession CDAs?

Answer: The DB QAP was developed for DB projects. It can be broken down into two parts. The first part contains DB CDA requirements for Developers that are contained in the QC, QA, and IA sections. It also describes requirements for OV and the interface between OV and the Developer's QC and QA. The second part contains the risk-based three-tiered verification approach with default levels of verification provided for design-build projects.

On concession projects, the Developer has long-term maintenance requirements; however, risk-based verification using the three-tiered approach is still applicable. The difference being that the levels of verification would be different because the Developer's long-term maintenance obligations and explicit handback requirements reduce TxDOT's residual risk.

6.2 Section 2 Examples and FAQs

6.2.1 Applicability of risk assessment workshop to concession CDAs

Question: Are the risk workshop process and procedures contained in this guide applicable to concession CDAs?

Answer: With respect to OV, the differences between DB and concession CDAs are in the contractual risk profile and the long-term Developer operations and maintenance. Each workshop evaluates project-specific conditions for the project, including the contractual risk profile, and evaluates TxDOT's residual risk after the Developer has completed its maintenance obligations. Therefore, while the outcome of risk workshop for a DB CDA and a concession CDA may be different, the fundamental principles and approach used are practically the same.

6.3 Section 3 Examples and FAQs

6.3.1 The “Engineer” on the project

Question: TxDOT specifications often refer to the role and responsibility of the “Engineer.” Who is the “Engineer” on a DB project and how is engineering authority granted?

Answer: In general terms, the Engineer on a DB project is the engineer responsible for acceptance of the items of work in question. Examples might include the Design Engineer, the Retaining Wall Engineer, and the Construction Quality Acceptance Manager (CQAM), for acceptance of materials testing results. The Contract documents should define the Engineer and his or her responsibility.

Engineering authority is normally granted to the CQAM for various types of tests. For example, engineering authority is normally granted for concrete slump. The CQAM will exercise engineering judgment to accept failing slump results, for example, and does not need to necessarily contact TxDOT for concurrence. However, the engineering reasoning behind all engineering judgments must be documented in the Engineering Judgment Log. Care must be taken when excessive engineering judgment is used. As an example, if the slump is consistently failing, yet the material is not segregated and is deemed acceptable for use, engineering judgment can be used for acceptance.; however, if the slump is consistently failing, then consideration must be given to whether the production process is out of control and needs to be investigated. In this example, the QC Manager should be notified to explore possible corrections to the failing concrete slumps and with the intent of bringing the slumps back in control.

6.3.2 TxDOT Guide Schedule compliance

Question: TxDOT’s Guide Schedule provides minimum testing frequencies normally conducted by TxDOT personnel. How does the Guide Schedule apply to DB projects?

Answer: The testing frequency outlined in the Guide Schedule is performed by the CQAF on a DB project. As reminder, the testing frequencies outlined in the Guide Schedule are minimum frequencies, and the CQAF is encouraged to increase testing frequencies during the start-up operations for each new material as prescribed in the Preamble of the Guide Schedule.

It should be noted that the Guide Schedule was written for traditional design-bid-build projects and care must be exercised when applying the Tables to a DB project. As an example, the Guide Schedule for testing Hydraulic Cement Concrete Pavements (Table V) is written from the perspective of meeting the requirements of Item 360. However, Item 360 places the testing responsibility on the Contractor for Job Control testing with verification performed by the Engineer. Table V indicates to perform compressive strength testing as “One test (2 specimens) for every 10 contractor job control testing”. This situation does not conform to the roles outlined on a DB project, where the Contractor is responsible for QC, the engineer performs testing for QA acceptance testing (not verification), and the owner (i.e., TxDOT or designee) performs OV testing. Thus, consideration must be given to defining what the testing frequencies should be based on a DB project.

6.3.3 I2MS system set-up

Question: What are the system set-up requirements for I2MS, and what type of project support is normally provided? Is the Developer required to use I2MS, or can they have their own materials management system?

Answer: Attachment F of this guide provides an I2MS Deployment Guide; however, this information is quite complicated for those who are not Database Administrators. Therefore, it is best to coordinate system set-up requirements through CST/M&P. The Developer requirements to use or not to use I2MS should be stated within the Contract language. There are laboratories that have their own computer system for generating test reports and tracking materials information. The system can communicate with I2MS using XML data transfer. Coordination to parse data into I2MS should also be coordinated through CST/M&P.

6.3.4 Role of IA in non-validation investigations

Question: Can the IA laboratory provide assistance during non-validation investigations? If so, how can their services best be utilized?

Answer: Contract language that allows the IA laboratory to provide assistance during non-validation investigations must be included with the IA Scope of Services. If allowed, the IA can assist in investigating both the QA and OV laboratories for equipment and testing procedure compliance.

6.3.5 CQAF inspection services

Question: On traditional projects, TxDOT personnel provide inspection services with an in-house mentoring program that provides training as well as monitors inspector's performance. What are the requirements and qualifications for CQAF inspectors? What measures can TxDOT take if the qualifications of the QA inspector appear inadequate?

Answer: If requirements and qualifications for CQAF inspectors is desired, they should be included with the CDA documents. Currently, TxDOT does not have formal requirements established for construction inspection qualifications. If qualifications of the QA inspector appear inadequate, then TxDOT should approach the CQAM with its concerns. Most often, additional on-site training can be performed for specific areas of concern.

6.3.6 Using QA Proctors for OV Testing

Question: In the Levels of Analysis table (see DB QAP Appendix D), Moisture-Density and In-Place Density is listed as a Level 3 and Level 1 category, respectively. Does the OV lab need to perform independent M-D curves for determining in-place densities, given that the M-D curve calculations are listed as a Level 3?

Answer: The FHWA does allow the OV lab to use QA proctor values for all calculations, but only when proctors are set as a Level 3 and in-place densities are set as a Level 1. If the OV lab elects to proceed with this option, clarification in the OVTIP must be added to ensure that accurate checks and balances are being conducted for determining the QA proctor values.

Example: OV use of QA proctor implementation guidance.

1. During startup operations, test 5 split samples with the QA and ensure that all values are within the split sample tolerance, currently set at 2.0 pcf of mean, as specified in Appendix B.
2. The QA must provide OV lab with complete curve data for all proctor tests. Prior to testing in-place densities, QA shall furnish the selected curve for each in-place density point.
3. The OV either agrees that the QA proctor is representative of the material being tested or the OV will obtain in-place density values and sample the material to conduct a one-point proctor to ensure that proctor values are within 2.0 pcf of curve estimates.

6.4 Section 4 Examples and FAQs

6.4.1 Failed compaction testing protocol

Question: Can you describe the process for re-testing failing compaction tests results that are not accepted through engineering judgment or a NCR?

Answer: When compaction tests results fail but are not accepted through engineering judgment or the NCR process, then the failed areas should be reworked or replaced by the Developer. The original sample type should have been labeled as a random independent test. Upon failure, this test is relabeled as fixed independent. Once the failed location is reworked or replaced, a new random independent test is performed. If the new random and the original fixed tests pass, then the material is considered acceptable.

6.4.2 Testing specific areas of concern

Question: The DB QAP requires that the CQAF meet the Guide Schedule frequency of tests with random-independent tests. Can specific areas of concern be tested, since they would not be considered random tests?

Answer: Yes, CQAF may test a specific area of concern (or material whose quality appears to be suspicious). This test should be labeled as a fixed-independent test. While fixed-independent tests do not count towards frequency compliance, the results of these tests must be addressed. If the test result does not meet specification requirements, the failing test result has to be addressed either through reworking the lot (if applicable), through engineering judgment, or the resolution of a NCR.

6.4.3 Quality Control testing

Question: Is the quality control program required to have independent laboratory testing of materials prior to requesting QA acceptance testing?

Answer: To better understand this answer, refer to Section 2 of the DB QAP. Several key references are provided below to justify the answer that the QC program must use laboratory testing results to ensure quality has been incorporated in the project prior to requesting QA acceptance testing.

1. Section 2.1 provides requirements of the QC program where the Developer is responsible for the quality of work through the defined processes, methods, procedures, and documentation of a systematic approach to delivery of QC on the project.
2. Section 2.2.1 indicates that “QC *testing* and inspection shall ensure quality has been incorporated into all elements of work prior to requesting acceptance testing and inspection.”

3. Furthermore, bullet point L of the QC requirements states that “written *test* procedures which include provisions for ensuring that all prerequisites for the given *test* have been met and that adequate *test* instrumentation is available and used.”

Note that the references above do not dictate, require, or disallow on-site laboratory to be used. The QC program may choose to house an on-site laboratory or use the supplier’s facility as part of the Quality Team approach. QC testing may include testing at the quarry or at the HMA plant. The process of QC testing should be clearly indentified within the QC portion of the CQMP.

6.4.4 Enforcement of Quality Control Commitments

The following example illustrates potential QC testing shortfalls that should be addressed by the OV oversight team. Consider the following example and how you would enforce the commitments of the QC program. When reading this example, keep in mind the following requirements of the DB QAP:

- When repeated observations of non-compliant work are observed by the CQAF, the DB QAP requires that the “QC program should be sufficient in scope to remedy repeated discoveries.” Thus, the CQCM should take additional measures to promote quality and consistency in material production and placement.
- There should be a “clear distinction between QC and QA activities, and the persons performing each function.” There will be instances, however, when the Owner is challenged with the fact that the lines between QC and QA activities seem to be blurred.

Example: Typical Concrete Placement Operations

Most QC testing of hydraulic cement concrete in the field consists of only temperature and air content (if applicable). If slump testing is performed, it is normally performed at the supplier or batch plant. Most contractors feel that slump testing in the field is optional. The QC staff normally performs a “visual” reading as it is being discharged from the concrete truck, and one of the following conditions usually occurs.

1. When field observations by QC staff indicate potential slump problems, the first reaction by the Owner is to require that QC staff test the concrete for compliance. However, the reality is additional testing by QC staff beyond what is performed by the supplier (considered a QC member) is rarely performed in the field. Rather, the QA staff is asked to perform the slump test. The question that needs to be asked is whether this practice is allowed by the DB QAP.
2. The DB QAP requires a clear distinction between QC and QA activities and the persons performing each function. QC is responsible for “process control” and QA is responsible for “acceptance”. Thus, in this example, the lines of testing appeared to be blurred.
3. Additional guidance can be found in the Guide Schedule. The Guide Schedule is written to establish the minimum testing frequencies for the engineer (in this case, the CQAF). For explanatory purposes, pertinent language below has been underlined which indicates that it is the CQAF’s responsibility to test the first few loads of concrete in the field for consistency for bridge slabs. The CQAF should label these tests as Fixed Independent.

TxDOT Guide Schedule of Sampling and Testing

For Class S, F, and H ready mix concrete for bridge slab only, air, slump, and temperature must be checked on the first few loads of concrete as necessary to obtain a desired

consistency. Thereafter, test each third load for both slump and air content. Perform slump and air content tests on the same load from which strength test specimens are made. Check temperature of every load for bridge slabs and mass concrete placements. When air-entrainment requirements have been waived by the plans but the concrete mix still includes an air-entrainment agent, continue to test for air at the listed frequency.

4. The above requirement is a standard practice that has occurred for many years within TxDOT at slab pours. The question is what practice is allowed for “other” classes of structural concrete (e.g., Class C for caps)?

Recommended Guidance

1. One option is to verify that QC testing was performed at the batch plant with results verbally provided to the field personnel. As required by the DB QAP, factual evidence that QC testing has occurred can be verified through the audit process at a later date. When the concrete arrives on-site, the QA representative performs slump, temperature, and air content (if required) and labels this as a fixed independent test. These results are shared with the QC staff, and a determination is made whether to continue, add free water, or reject the load. When the QA tests at the random number location, then fresh and hardened properties are tested for acceptance.
2. The above scenario is meant to bring awareness to the Owner or Materials Manager that the means and methods of Traditional projects do not necessarily apply to Design-Build projects, and roles and responsibilities should be clearly communicated prior to field operations beginning.

When faced with the above situation, consider the risk management that must be understood between QC ensuring that the material is delivered in a consistent manner (i.e., process control) and the QA testing the material for acceptance. These situations need to be resolved quickly so that material quality is not adversely affected and interruptions to the pour sequence are minimized. It is suggested that this topic be discussed at the Weekly Materials Coordination Meeting prior to the first concrete pour so that all team members clearly understand their roles during concrete placement activities.

6.4.5 Quality Acceptance testing

Question: Section 3.7 indicates that material quality must be evaluated immediately to determine if it can be left in place or has to be removed, reworked, or repaired. The DB QAP provides guidance based on four combinations of passing and failing results between the QA and the OV test results. How is the guidance provided in the DB QAP implemented for earthwork operations?

Answer: As was expressed in Section 3.4.2, the lines between QC and QA testing can sometimes blur. To further illustrate this point from the perspective of QA operations, consider the situation when testing embankment for in-place density. The same basic rules apply in that the QC program must be sufficient in scope to remedy repeated discoveries and provide clear distinctions between QC and QA activities, and the persons performing each function, must be maintained.

Example: In-Place Density of Embankment

After processing of materials and completion of compaction operations, the QC foreman or superintendent will request acceptance testing by the CQAF. The decision by the QC staff to proceed is normally based on field experience and rarely on field testing. This situation will be discussed, and recommended guidance

will be provided; however, the following best practice for nuclear density testing on DB projects will be discussed to lay the framework for the example problem.

1. When the QA representative is asked to perform testing, a random number (station and offset) is generated. The applicable forms are completed in preparation for the test, and a proctor is selected (if available).
2. A random independent QA test is performed and compared to specification limits.
3. When the test passes, the OV representative is provided the opportunity of testing based on their random independent number.
4. When the test fails, the following two scenarios are applied.
 - a. A QA failure requires the Developer to rework the area and request further acceptance testing. The first random independent test taken in step 2 above is now considered a fixed independent and must be retested and pass before the entire lot can be accepted.
 - b. In addition, a new QA random independent test is performed and it must also pass before the entire lot can be accepted.
5. The process described in step 4 will continue until all fixed tests pass along with the new random independent test.

A problem often arises in the field when the formal steps described above are not followed. When QC requests testing by QA, not for the purpose of acceptance but for the purpose of identifying where they are within the compaction process, the lines between QC and QA are blurred. Such requests by the QC should be denied, and the QC program should rely on testing performed by QC personnel. To eliminate the possibility of this occurring, every QA test taken must be for the purpose of acceptance and must be recorded. When the recorded test result fails, then the formal steps described in step 4 will apply.

6.4.6 Providing active materials management

Question: Level 1 (Continuous Analysis) procedures provide the ability to monitor validation over time. How can the trend lines be used to provide active materials management on a project? When materials trend toward non-validation, when should an investigation begin?

Answer: Monitoring the results of Level 1 (Continuous Analysis) over time provides the ability to proactively observe trends in materials testing results. When trend lines start declining over time toward the point of non-validation, then steps can be taken to potentially correct negative trending and bring the material category into validation. Steps can begin to proactively monitor testing results, testing procedures, and technicians with the intent of focusing greater attention on the material category. However, when five or more non-validations occur, then a formal investigation is required. This formal investigation is conducted by the OV staff in cooperation with members of the CQAF.

6.4.7 FHWA quarterly report

Question: Are there specific requirements, content, and format of the FHWA quarterly report?

Answer: The required components of the FHWA quarterly report are provided in Section 4.3. A formal format has not been established for the layout of the report. However, best practices have indicated that the

report should contain a cover letter, table of contents, executive summary, body of report to include each material category tested, results of the three levels of analysis, split sample program results, non-validation investigations, conclusions, and various appendices.

6.5 Section 5 Examples and FAQs

6.5.1 FHWA quarterly versus final validation reports

Question: Are there any different requirements between regular FHWA quarterly validation reports and the final FHWA validation report?

Answer: Section 5.1 provides implementation guidance on this topic in further detail. Briefly stated here, the final FHWA quarterly report will provide results from the last quarter of testing. When materials are not validating on the last quarter (or from previous quarters), then a disposition on this material needs to be determined. It is important to realize that only OV results will be considered for material acceptance, since the validation with the QA was not achieved. The final report will therefore describe the OV testing results and final disposition for those materials not in conformance with the materials specifications.

Attachment A
List of Acronyms and Abbreviations

List of Acronyms and Abbreviations

The following terms and definitions are referenced in this guide and have the meanings set forth below:

AAP	AASHTO Accreditation Program
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AMRL	AASHTO Materials Reference Laboratory
AQMP	Aggregate Quality Monitoring Program
ASTM	American Society for Testing and Materials
BRSQC	Bituminous Rated Source Quality Catalog
CCRL	Concrete and Cement Reference Laboratory
CDA	Comprehensive Development Agreement
CFR	Code of Federal Regulations
CQAF	Construction Quality Acceptance Firm
CQAM	Construction Quality Acceptance Manager
CQCM	Construction Quality Control Manager
CQMP	Construction Quality Management Plan
CST/M&P	TxDOT Construction Division, Materials and Pavements Section
CVL	Controlled Vocabulary List
DB	Design-Build
DMS	Departmental Material Specification
ESC	Early Start of Construction
FCR	Field Clarification Request
FHWA	Federal Highway Administration
I2MS	Inspection and Materials Management System
IA	Independent Assurance
MOT	Maintenance of Traffic
MOU	Memoranda of Understanding
MPL	Material Producer List
NCR	Nonconformance Record
NEPA	National Environmental Policy Act
NHI	National Highway Institute
OV	Owner Verification
OVTIP	Owner Verification Testing and Inspection Plan
QA	Quality Acceptance

QAP	Quality Assurance Program
QC	Quality Control
QMP	Quality Monitoring Program
RFC	Release for Construction
RFI	Request for Information
RFP	Request for Proposal
SEP-15	Special Experimental Project Number 15 or SEP-15 derives
SHA	State Highway Agency (The SHA is TxDOT for the purpose of this guide.)
SSL	Secure Socket Layer
SUE	Subsurface Utility Engineering
TWG	Technical Working Group
TxAPA	Texas Asphalt Pavement Association
TxDOT	Texas Department of Transportation
XML	Extensible Markup Language

Acceptance Program shall mean the all factors that comprise the State highway agency's program (SHA) to determine quality of the product as specified in the contract requirements. These factors include acceptance and validation sampling, testing, and inspection and may include results of quality control sampling and testing.

CDA Documents shall have the meaning set forth in the executed agreement between TxDOT and Developer.

Controlled Vocabulary List shall mean the list of agreed-upon nomenclature used to uniquely identify each QA and OV testing report.

Construction Quality Acceptance Firm shall mean the independent construction quality acceptance firm required as part of the Developer's team.

Design Firm shall mean the qualified Licensed Professional Engineer's firm responsible for the design of the Project.

Design Documents shall mean all drawings (including plans, profiles, cross-sections, notes, elevations, sections, details, and diagrams); specifications; reports; studies; calculations; electronic files; and records and submittals necessary for, or related to, the design of the Project and/or the Utility Adjustments in accordance with the CDA Documents, the Governmental Approvals, and applicable Law.

Developer shall mean the entity identified in the Agreement to perform Work under the Project, together with its successors and assigns.

Engineer in Responsible Charge shall mean the professional engineer accountable for direction, control, and supervision to assure that the Work has been critically examined and evaluated for compliance with appropriate professional standards and the requirements of the CDA Documents and the Maintenance Agreement Documents, as applicable.

Final Acceptance shall mean the occurrence of all of the events and satisfaction of all of the conditions set forth in the CDA Documents, as and when confirmed by TxDOT's issuance of a certificate of Final Acceptance.

F-test shall mean the statistical analysis to compare the variances of two sets of data.

Governmental Approval shall mean any permit, license, consent, concession, grant, franchise, authorization, waiver, variance or other approval, guidance, protocol, mitigation agreement, or memoranda of agreement/understanding, and any amendment or modification of any of them provided by Governmental Entities, including State, local, or federal regulatory agencies, agents, or employees, which authorize or pertain to the Work or the Project, but excluding any such approvals given by or required from any Governmental Entity in its capacity as a Utility Owner.

Governmental Entities shall mean any federal, State, or local government and any political subdivision or any governmental, quasi-governmental, judicial, public or statutory instrumentality, administrative agency, authority, body, or entity other than TxDOT.

Independent Assurance Program shall mean all activities that are included in an unbiased and independent evaluation program for all the sampling and testing procedures used in the Acceptance Program.

Law or **Laws** means (a) any statute, law, code, regulation, ordinance, rule, or common law, (b) any binding judgment (other than regarding a Claim or Dispute), (c) any binding judicial or administrative order or decree (other than regarding a Claim or Dispute), (d) any written directive, guideline, policy requirement, or other governmental restriction (including those resulting from the initiative or referendum process, but excluding those by TxDOT within the scope of its administration of the CDA Documents), or (e) any similar form of decision of or determination by, or any written interpretation or administration of any of the foregoing by, any Governmental Entity, in each case which is applicable to or has an impact on the Project or the Work, whether taking effect before or after the Effective Date, including Environmental Laws. "Laws", however, excludes Governmental Approvals.

Level of Significance (alpha) shall mean the probability of erroneously rejecting the null hypothesis when it should have been accepted.

Nonconforming Work (Nonconformance) shall mean Work that has not been constructed with the strictest adherence to the approved drawings and specifications and with the requirements of the Contract Documents, the Governmental Approvals, and applicable Law.

Nonconformance Record (NCR) shall mean a record of how Nonconforming Work was accepted for incorporation into the Work.

Proficiency Samples shall mean homogenous samples that are distributed and tested by two or more laboratories and/or personnel. The test results are compared to assure that the laboratories and/or personnel are obtaining the same results.

Project shall have the meaning set forth in Recital B to the Agreement.

Qualification shall mean a quality, ability, or accomplishment that makes a person technically competent for a particular position or task.

Quality Acceptance shall mean all planned and systematic actions performed by the CQAF as defined in the CDA for their portion of the acceptance decision.

Quality Assurance shall mean all planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.

Quality Assurance Program shall mean the program for quality management and control of the Project and Work, as described in the CDA Documents.

Quality Control shall mean all contractor/vendor operational techniques and activities that are performed or

conducted to fulfill the contract requirements.

Random Sampling shall mean a process whereby each element of the population has an equal chance of being selected.

Licensed Professional Engineer shall mean a person who is duly licensed by the Texas Board of Professional Engineers to engage in the practice of engineering in the State.

Rules shall mean Texas Administrative Code.

Split Samples shall mean samples that are divided homogeneously from a single source and tested by two or more laboratories.

Substantial Completion shall mean the occurrence of all of the events and satisfaction of all of the conditions set forth in the Agreement, as and when confirmed by TxDOT's issuance of a Certificate of Substantial Completion.

Subcontractor shall mean any parties with whom Developer has entered into any Subcontract to perform any part of the Work or provide any materials, equipment, or supplies for the Project on behalf of Developer and any other party with whom any Subcontractor has further subcontracted any part of the Work, at all tiers.

Supplier shall mean any Person not performing work at or on the Site that supplies machinery, equipment, materials, hardware, software, systems, or any other appurtenance to the Project to Developer or to any Subcontractor in connection with the performance of the Work. Persons who merely transport, pick up, deliver, or carry materials, personnel, parts or equipment, or any other items or persons to or from the Site shall not be deemed to be performing Work at the Site.

TxDOT Standard Specifications shall mean the Texas Department of Transportation Standard Specifications for Construction of Highways, Streets, and Bridges, adopted by the Texas Department of Transportation including all revisions thereto applicable on the effective date of the agreement.

t-test shall mean the statistical analysis to compare the variances of two sets of data.

Utility or **utility** shall mean a public, private, cooperative, municipal and/or government line, facility, or system used for the carriage, transmission, and/or distribution of cable television, electric power, telephone, telegraph, water, gas, oil, petroleum products, steam, chemicals, hydrocarbons, telecommunications, sewage, storm water not connected with the drainage of the Project, and similar substances that directly or indirectly serve the public.

Utility Owner shall mean the owner or operator of any Utility (including both privately held and publicly held entities, cooperative utilities, and municipalities and other governmental agencies).

Vendor shall mean a supplier of project-produced material that is not the contractor.

Verification Testing shall mean sampling and testing performed to validate the quality of the product. The sampling and testing are to be performed by qualified testing personnel employed by the SHA or its designated agent, excluding the contractor and vendor.

Work shall mean all of the work required under the CDA Documents, including all administrative, design, engineering, real property acquisition and occupant relocation, support services, utility adjustment work to be furnished or provided by Developer, reimbursement of Utility Owners for utility adjustment work furnished or provided by such Utility Owners or their contractors and consultants, procurement, professional, manufacturing, supply, installation, construction, supervision, management, testing, verification, labor, materials, equipment, maintenance, documentation, and other duties and services to be furnished and provided by Developer as required by the CDA Documents, including all efforts necessary or appropriate to achieve Final Acceptance, except for those efforts which such CDA Documents expressly specify will be performed by parties other than the Developer-related entities.

Attachment B
Code of Federal Regulations
23 CFR 637 B

Federal Highway Administration, DOT

§ 637.207

**Subpart B—Quality Assurance
Procedures for Construction****§ 637.201 Purpose.**

To prescribe policies, procedures, and guidelines to assure the quality of materials and construction in all Federal-aid highway projects on the National Highway System.

§ 637.203 Definitions.

Acceptance program. All factors that comprise the State transportation department's (STD) determination of the quality of the product as specified in the contract requirements. These factors include verification sampling, testing, and inspection and may include results of quality control sampling and testing.

Independent assurance program. Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. Test procedures used in the acceptance program which are performed in the STD's central laboratory would not be covered by an independent assurance program.

Proficiency samples. Homogeneous samples that are distributed and tested by two or more laboratories. The test results are compared to assure that the laboratories are obtaining the same results.

Qualified laboratories. Laboratories that are capable as defined by appropriate programs established by each STD. As a minimum, the qualification program shall include provisions for checking test equipment and the laboratory shall keep records of calibration checks.

Qualified sampling and testing personnel. Personnel who are capable as defined by appropriate programs established by each STD.

Quality assurance. All those planned and systematic actions necessary to provide confidence that a product or service will satisfy given requirements for quality.

Quality control. All contractor/vendor operational techniques and activities that are performed or conducted to fulfill the contract requirements.

Random sample. A sample drawn from a lot in which each increment in the

lot has an equal probability of being chosen.

Vendor. A supplier of project-produced material that is not the contractor.

Verification sampling and testing. Sampling and testing performed to validate the quality of the product.

§ 637.205 Policy.

(a) *Quality assurance program.* Each STD shall develop a quality assurance program which will assure that the materials and workmanship incorporated into each Federal-aid highway construction project on the NHS are in conformity with the requirements of the approved plans and specifications, including approved changes. The program must meet the criteria in § 637.207 and be approved by the FHWA.

(b) *STD capabilities.* The STD shall maintain an adequate, qualified staff to administer its quality assurance program. The State shall also maintain a central laboratory. The State's central laboratory shall meet the requirements in § 637.209(a)(2).

(c) *Independent assurance program.* Independent assurance samples and tests or other procedures shall be performed by qualified sampling and testing personnel employed by the STD or its designated agent.

(d) *Verification sampling and testing.* The verification sampling and testing are to be performed by qualified testing personnel employed by the STD or its designated agent, excluding the contractor and vendor.

(e) *Random samples.* All samples used for quality control and verification sampling and testing shall be random samples.

§ 637.207 Quality assurance program.

(a) Each STD's quality assurance program shall provide for an acceptance program and an independent assurance (IA) program consisting of the following:

(1) Acceptance program.

(i) Each STD's acceptance program shall consist of the following:

(A) Frequency guide schedules for verification sampling and testing which will give general guidance to personnel responsible for the program

§ 637.209

and allow adaptation to specific project conditions and needs.

(B) Identification of the specific location in the construction or production operation at which verification sampling and testing is to be accomplished.

(C) Identification of the specific attributes to be inspected which reflect the quality of the finished product.

(ii) Quality control sampling and testing results may be used as part of the acceptance decision provided that:

(A) The sampling and testing has been performed by qualified laboratories and qualified sampling and testing personnel.

(B) The quality of the material has been validated by the verification sampling and testing. The verification testing shall be performed on samples that are taken independently of the quality control samples.

(C) The quality control sampling and testing is evaluated by an IA program.

(iii) If the results from the quality control sampling and testing are used in the acceptance program, the STD shall establish a dispute resolution system. The dispute resolution system shall address the resolution of discrepancies occurring between the verification sampling and testing and the quality control sampling and testing. The dispute resolution system may be administered entirely within the STD.

(iv) In the case of a design-build project on the National Highway System, warranties may be used where appropriate. See 23 CFR 635.413(e) for specific requirements.

(2) The IA program shall evaluate the qualified sampling and testing personnel and the testing equipment. The program shall cover sampling procedures, testing procedures, and testing equipment. Each IA program shall include a schedule of frequency for IA evaluation. The schedule may be established based on either a project basis or a system basis. The frequency can be based on either a unit of production or on a unit of time.

(i) The testing equipment shall be evaluated by using one or more of the following: Calibration checks, split samples, or proficiency samples.

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(ii) Testing personnel shall be evaluated by observations and split samples or proficiency samples.

(iii) A prompt comparison and documentation shall be made of test results obtained by the tester being evaluated and the IA tester. The STD shall develop guidelines including tolerance limits for the comparison of test results.

(iv) If the STD uses the system approach to the IA program, the STD shall provide an annual report to the FHWA summarizing the results of the IA program.

(3) The preparation of a materials certification, conforming in substance to Appendix A of this subpart, shall be submitted to the FHWA Division Administrator for each construction project which is subject to FHWA construction oversight activities.

(b) In the case of a design-build project funded under title 23, U.S. Code, the STD's quality assurance program should consider the specific contractual needs of the design-build project. All provisions of paragraph (a) of this section are applicable to design-build projects. In addition, the quality assurance program may include the following:

(1) Reliance on a combination of contractual provisions and acceptance methods;

(2) Reliance on quality control sampling and testing as part of the acceptance decision, provided that adequate verification of the design-builder's quality control sampling and testing is performed to ensure that the design-builder is providing the quality of materials and construction required by the contract documents.

(3) Contractual provisions which require the operation of the completed facility for a specific time period.

[60 FR 33717, June 29, 1995, as amended at 67 FR 75934, Dec. 10, 2002]

§ 637.209 Laboratory and sampling and testing personnel qualifications.

(a) Laboratories.

(1) After June 29, 2000, all contractor, vendor, and STD testing used in the acceptance decision shall be performed by qualified laboratories.

(2) After June 30, 1997, each STD shall have its central laboratory accredited

Attachment C
FHWA Technical Advisory T 6120.3

Technical Advisory

Use of Contractor Test Results in the Acceptance Decision, Recommended Quality Measures, and the Identification of Contractor/Department Risks

T 6120.3

August 9, 2004

Par.

1. What is the purpose of this Technical Advisory?
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 16. What are contractor and department risks?
 17. Are there any conflicts between American Association of State Highway and Transportation Officials (AASHTO) quality assurance publications and FHWA regulations?
 18. Are there any reference materials on quality assurance, risks, and statistics?
1. **What is the purpose of this Technical Advisory?** This Technical Advisory provides guidance and recommendations for the use and validation of contractor's test results for acceptance, the use of quality measures, and the identification of contractor and department risks.
 2. **Does this Technical Advisory supersede other Federal Highway Administration (FHWA) guidance?** Yes. This Technical Advisory supersedes previous guidance provided in the following:
 - a. *Memorandum from Director, Office of Engineering, to Regional Administrators, "INFORMATION: Quality Assurance Procedures for Construction - 23 CFR 637 - Sampling for Verification Testing,"* March 28, 1997.
 - b. *Memorandum from Chief, Highway Operations Division, to Regional Administrators, Division Administrators, Federal Lands Highway Program Administrator, "INFORMATION: Quality Assurance Guide Specification and Implementation Manual for Quality Assurance,"* August 2, 1996.
 3. **What is FHWA's policy on the use of contractor's quality control test results for acceptance?** The FHWA policy on the use of contractor's quality control test results for acceptance requires **validation** of all data not generated by the State transportation department (STD) or its designated agent if used in the acceptance decision. The requirements are codified in Title 23 Code of Federal Regulations Part 637 Subpart B (23 CFR 637B), located at http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr637_03.html. (Note that the use of STD is in line with 23 CFR 637 B, as of April 1, 2003. In this Technical Advisory, all references to State Highway Agency (SHA) or "agency" have been replaced with STD or "department.")
 4. **Is there any existing FHWA guidance regarding 23 CFR 637B, the use of quality measures, and the identification of contractor and department risks?** Yes. Existing FHWA guidance is provided in the following:

- a. *FHWA Materials Notebook: Chapter 1 - Materials Sampling and Testing* 23 CFR 637, "23 CFR 637 ACTION: Final Rule and Questions & Answers on the Regulation," http://www.fhwa.dot.gov/pavement/materials_notebook/1sec1.htm.
- b. *Publication No. FHWA-RD-02-095 "Optimal Procedures for Quality Assurance Specifications"* (see paragraph 18b), <http://www.tfhrc.gov/pavement/pccp/pubs/02095/>.
- c. *Memorandum from Chief, Highway Operations Division, to Resource Center Directors, Division Administrators, "INFORMATION: Laboratory Qualification,"* October 9, 1998, <http://www.fhwa.dot.gov/pavement/labqual.htm>.
- d. *Memorandum from Chief, Highway Operations Division, to Resource Center Directors, Division Administrators, Acting Federal Lands Highway Program Administrator, "INFORMATION: Technician Qualification,"* July 17, 1998, <http://www.fhwa.dot.gov/pavement/techqual.htm>.

5. **What is the background on quality assurance and quality assurance specifications?**

- a. One of the fundamental concepts in quality assurance (QA) specifications is the separation of the functions of quality control (QC) and acceptance. In QA specifications, the contractor is responsible *for the QC and the STD is responsible for obtaining and conducting verification tests and making the acceptance decision*. Although QA is a combination of QC and acceptance, the separation of these two functions is important.
- b. Due to the evolutionary nature of QA specifications, QC and acceptance functions often have been combined or intermingled. This has been a major source of confusion. The intermingling of QC and *acceptance* can be traced to the first statistically based specifications that were used at a time when STDs had technicians at the contractor's materials plants. The STD technicians did testing and determined when the product was acceptable. Contractors rarely did their own QC testing, and they often made changes to the process when necessary based on the STD's test results. Although QC was often recognized as a separate item from acceptance, in reality, little separation occurred.
- c. With the downsizing that took place within many STDs in the 1990s, inspection and testing personnel positions were reduced significantly and many technicians were removed from the contractors' materials plants. Although STDs often took it upon themselves to control most aspects of production and construction, reductions in staff made it more important to assign QC where it rightfully belonged so the STD could focus on acceptance testing and inspection. This resulted in the contractor having to conduct the QC tests and the STD examining options for requiring more of its functions to be undertaken by the contractor. Many STDs found ways to include contractor test results in the acceptance decision, and some have questioned why the regulations prohibit the contractor from conducting acceptance testing.
- d. The Federal regulations on sampling and testing of materials for construction appear in 23 CFR 637B (see paragraph 18a). These regulations were revised on June 29, 1995. This revision included *clarification* on the use of contractor test results in an acceptance program. The regulations most recent revision occurred in the *Federal Register* on December 10, 2002.
- e. *Further* evolution of QA specifications has introduced the use of incentive/disincentive provisions and pay adjustment systems that utilize pay factors to adjust the amount paid to a contractor based on the level of quality of the product provided. Several different statistical quality measures were developed and used in order to determine this level of quality. Some examples of quality measures are: percent within limits, percent defective, average deviation, average absolute deviation, conformance index, and moving average. Some of these quality measures have been implemented without fully understanding how they apply to acceptance or whether they conform to sound statistical principles.
- f. Statistical QA specifications and acceptance procedures have been implemented without fully understanding the risks involved to both the STD and the contractor. The acceptable level of STD risk and contractor risk is a subjective decision that often varies between departments. It is estimated that few departments have developed and evaluated the risk levels associated with their acceptance plans.
- g. State planning and research pooled fund study SPR-2(199) "Optimal Acceptance Procedures for *Statistical Construction Specifications*" was conducted in order to investigate the current use of QA specifications and

provide recommendations for statistically sound QA procedures and balancing of risks. The pooled fund study was administered by FHWA and the results provided in publication no. FHWA-RD-02-095, "Optimal Procedures for Quality Assurance Specifications" (see paragraph 18b). This publication provides a guide for developing new or modifying existing acceptance plans and QA specifications.

6. **Where can I find definitions for the terms used within this Technical Advisory?** The definitions for terms used in this Technical Advisory are taken from the following sources (listed in order of precedence), unless otherwise specified:
- 23 CFR 637 (see paragraph 18a).
 - AASHTO R10 (see paragraph 18e).
 - Transportation Research Board (TRB) Circular (see paragraph 18f).
7. **Do any of the terms need additional explanation?** Some additional explanations of terms are provided below:
- Difference Two-Sigma Limit (D2S Limit).** The D2S method compares the contractor and department results from a single split sample. The D2S Limit indicates the maximum acceptable difference between two test results obtained on test portions of the same material (and thus, applies only to split samples), and it is provided for single and multi-laboratory situations. It represents the difference between two individual test results that has approximately a five percent chance of being exceeded if the tests are actually from the same population. The value provided by this procedure is contained in many AASHTO and American Society of Testing and Materials (ASTM) test procedures and is typically listed in the precision and bias statement as "Acceptable Range of Two Test Results" at the end of each test procedure.
 - F-test.** The *F*-test provides a method for comparing the variances (standard deviations squared, σ^2) of two sets of data by assessing the size of the ratio of the variances. The hypothesis is that the department's tests and the contractor's tests are from the same population and the variability of the two data sets are equal. The intent is to determine whether the differences in the variability of the contractor's tests and the department's tests are larger than might be expected by chance if they came from the same population. The calculated *F*-value is then compared to the critical value (F_{crit}) obtained from a table of *F*-values at a chosen level of significance (α). The *F*-test can be used to compare either an equal or unequal number of contractor vs. department sample sizes.
 - Operating Characteristics (OC) Curves**
 - (1) OC curves for statistical tests. OC curves can be developed to indicate the probability of rejecting a hypothesis. This type of curve shows the relation between the probability of rejecting a hypothesis that a sample belongs to a given population with a given characteristic and the actual population value of that characteristic. OC curves can also be developed to show either the probability of not detecting a difference, or detecting a difference, versus the actual difference between the two populations being compared. There are also OC curves available to provide guidance regarding the number of tests needed to achieve a certain probability of detecting a given difference when one actually exists. OC curves that plot the probability of detecting a difference are sometimes called power curves because they plot the power of the statistical test procedure to detect a given difference.
 - (2) OC curves for acceptance plans. OC curves can also be a graphical representation of an acceptance plan that shows a relationship between the actual quality of a lot and either (a) the probability of its acceptance (for accept/reject acceptance plans), or (b) the probability of its acceptance at various pay levels for acceptance plans that include pay adjustment provisions.
 - Paired *t*-test.** The paired *t*-test compares contractor and department results from an equal number of split samples. When it is desirable to compare more than one pair of split sample test results, the *t*-test for paired measurements can be used. This test uses the differences between pairs of tests and determines whether the average difference is statistically different from zero. Thus, it is the difference within pairs, not between pairs, that is being tested. The calculated *t*-value is compared to the critical value (t_{crit}) obtained from a table of *t*-values at a specified level of significance and with $n-1$ degrees of freedom (see *t*-test in paragraph 7e).
 - t*-test**

- (1) The t -test provides a method for comparing the means of two independent data sets and is used to assess the degree of difference in the means. The null hypothesis is that the department's tests and the contractor's tests are from the same population, and the means of the two data sets are equal. The desire is to determine whether it is reasonable to assume that the contractor's tests came from the same population as the department's tests. The t -test can be used to compare either an equal or unequal number of contractor vs. department sample sizes.
 - (2) Since the values used for the t -test are dependent upon whether or not the variances are assumed equal for the two data sets, it is necessary to test the variances (F -test) before the means (t -test). If it is determined that the variances are assumed to be equal ($F < F_{crit}$), then the t -test is conducted based on the two sample sets using a pooled estimate for the variance and pooled degrees of freedom. If the sample variances are determined to be different ($F \geq F_{crit}$), then the t -test is conducted using the individual sample variances, the individual sample sizes, and the effective degrees of freedom. The calculated t -value is compared to the critical value (t_{crit}) obtained from a table of t -values at a specified level of significance.
8. **What are the requirements for the use of independent samples?** The regulation 23 CFR 637B requires the use of independent samples for verification sampling and testing in the acceptance program. In order to be considered independent, each sample must contain independent information reflecting all sources of variability associated with the material, process, sampling, and testing in the test results. This does not prevent split samples from being used in the acceptance decision if the data is used properly to provide validation of independent data (see paragraph 13). Some clarification of using contractor performed sampling for verification sampling and for use in the acceptance decision is found in paragraphs 9 through 13.
9. **Who is required to perform verification sampling and testing?**
- a. The regulation requires STD personnel or their representatives to perform the verification sampling and testing. The regulation also specifically indicates that verification sampling and testing cannot be performed by contractor employees. However, there are situations where labor regulations, hazardous conditions, and liability issues may dictate some contractor involvement in verification sampling. In these situations, the involvement of contractor personnel should be limited so that they are not deemed to be in control of the sampling.
- (1) The STD can use the services of the contractor's personnel to assist in obtaining independent verification samples when the following requirements are adhered to:
 - (a) The verification sample location or time has been randomly selected by the STD and is only given to the contractor immediately prior to sampling.
 - (b) The contractor's personnel are used only to provide labor to assist in physically obtaining the verification sample of the material.
 - (c) The STD is present to witness the taking of the verification sample.
 - (d) Both the STD witness and contractor labor are qualified sampling personnel.
 - (e) The STD witness controls the sampling process by choosing the location or timing and directing the taking of the verification sample.
 - (f) The STD witness immediately takes possession of the verification sample.
 - (2) STD verification sample independence and the intent of 23 CFR 637B are maintained when the above requirements are met. However, these situations should be the exception and not the rule. The verification sampling is expected to be performed entirely by STD personnel or their representative in the majority of situations.
- b. Verification testing is required to be performed by the STD or its designated agent, excluding the contractor or vendor; therefore, verification testing cannot be based on contractor performed testing witnessed by the STD.
10. **What are the validation procedures performed on independent samples?** When comparing two data sets, such as department and contractor test results, it is important to compare both the variances and the means. The tests most

often used are the F -test (comparison of variances) and the t -test (comparison of means), which are used together. A procedure that compares a single department test with 4 to 10 contractor tests is sometimes used but not recommended.

- a. The F -test and t -test are the recommended methods because they have more power to detect actual differences than the method that relies on a single department test for the comparison. If either the F -test or the t -test show a significant difference ($F \geq F_{crit}$ or $t \geq t_{crit}$), it is questionable whether the data does truly come from the same population.
 - (1) The computational method used for the t -test differs depending on if the variances are found to be either equal or not equal. There is a t -test that corresponds with finding a difference in variances, $F \geq F_{crit}$ (see paragraph 7e). This has led to instances of incorrectly validating test results by finding no differences in the means ($t < t_{crit}$) after finding differences in the variances ($F \geq F_{crit}$). When a difference in the variances is identified then the test results have not been validated, even if no difference in the means has been identified.
 - (2) The source of the difference should be identified if it is determined that a significant difference is likely between either the variances or the means. The identification of a difference between either variances or means is simply a notice that a difference exists. Therefore, the source of the difference must still be determined.
- b. The method of comparing a single department test to a number of contractor tests should not be used. Although simple, it suffers from the fact that only a single department test is used when making the comparison. Any comparison method that is based on a single test result is not effective in detecting differences between data sets. This is due to the high variability that is associated with individual values, as compared with mean values.

11. **What are the test method comparison procedures performed on split samples?**

- a. The comparison of a single split sample by using the D2S limits is simple and can be done for each split sample that is obtained. However, since it is based on comparing only single data values, it is not very powerful for identifying differences when they exist. Thus, it cannot detect real differences unless the results are far apart. The appeal of the D2S method lies in its simplicity rather than its power.
- b. Due to D2S method limitations, it is recommended that the paired t -test (see paragraph 7d) be used on the total accumulated split sample results to allow for a comparison with more discerning power. If either of these comparisons indicates a difference, then an investigation to identify the cause of the difference should be initiated.

12. **When should split samples be used?** The split sampling, testing, and comparison procedures (see paragraph 11) are primarily used as a function of an Independent Assurance (IA) program as outlined in 23 CFR 637B. The use of split samples in the IA program provides a check on testing equipment and procedures. The evaluation of split samples helps to identify where the cause of any differences may occur by isolating the testing components. This complements the QA program and ensures credibility of the testing program.

13. **Can contractor split sample test results be used in the acceptance decision?**

- a. In order for contractor split sample test results to be used in the acceptance decision, the contractor's test results used in the acceptance decision must be independently validated by the STD. The validation is not required if the STD conducts all of the verification sampling and testing and does not wish to use the contractor's test results in the acceptance decision.
- b. The contractor performs QC testing using independently obtained samples. The STD can perform verification testing using its half of the split samples when sampled as required in paragraph 9. The validation is accomplished by comparing the STD verification tests with the contractor's independently sampled QC tests (see [Figure 1](#)). The contractor's splits of the verification samples cannot be used for validation purposes because they are not independent of the STD samples. If both sets of split samples are used the only component of variability that can be compared is the testing variability. The split sample components of variability associated with materials, process, and sampling are the same, having come from the same location and sampler.

- c. The contractor may or may not test their portion of the split sample. The validation procedure is the same in either case because the contractor's split samples cannot be used for validation (see [Figure 1](#)).
- d. When the STD uses contractor personnel as labor to take verification samples as required in paragraph 9 and the STD then performs verification testing on these samples, the verification test results may be considered independent of the contractor's test results. They may be considered independent because they have been sampled with control by the STD, independently tested, and independently compared to the contractor's independent QC test results (test results that do not include the contractor's set of split samples). Again, in order to be considered independent the two sets of samples must each contain the variability associated with the material, process, sampling, and testing.
- e. If the contractor's independently sampled QC test results are validated by the STD verification test results, then the material can be accepted based on either:
- (1) The total test results provided by the contractor that combine their independent QC test results and their split of the verification sample test results (see 2.1 in [Figure 2](#)),
 - (2) A combination of independent contractor QC test results excluding their split sample test results and the STD verification split test results (see 2.2 in [Figure 2](#)), or
 - (3) Only the contractor independent QC test results, excluding all split sample test results (see 2.3 in [Figure 2](#)).
- f. The STD test results from their split portion of the verification samples and the contractor test results from their split portion of the of the verification samples cannot be combined for the acceptance decision (see 2.4 in [Figure 2](#)). If the two sets of split test results are combined, they are no longer independent and the population of the contractor's independent test results will be biased and result in an invalid comparison. In essence, a double counting of test results would occur if the two sets of split test results were combined. This is true even though the two sets of test results may have different values.
- g. A scenario may exist where all samples are taken by the STD and split between the STD and contractor. In this scenario the STD only performs verification tests on a specified percentage of all the split samples they have in their possession. It is important to note, the validation must still be performed on independent sample data. Again, this is accomplished by comparing the STD verification test results with the contractor's independent test results. The contractor's independent test results cannot include the split tests that match with the STD verification tests.
- (1) For example, if 11 samples were split, the contractor tests all 11 samples and the STD tests only 3 samples, the 3 STD test results would be compared against the contractor's remaining 8 test results. Independence of the two sets of data is maintained by excluding the contractor's three test results that match the STD test results.
 - (2) In essence, the validation shown in [Figure 1](#) has occurred when the STD does not test all of the split samples that are in its possession. By taking possession of all the split samples, the STD does have additional material for an investigation if the contractor's results do not validate or for use in a dispute resolution system.
- h. Although split samples have physically been taken, it is the method which the data from these samples is analyzed that allows independent validation and their use in the acceptance decision. The independent validation is accomplished by validation procedures performed on independent samples (see paragraph 10), not by test method comparison procedures performed on split samples (see paragraph 11).
14. **What are the recommended quality measures?** The percent within limits (PWL) or percent defective (PD) are the recommended quality measures to be used. It is necessary to measure both the center and spread when characterizing a lot of material. These quality measures use the mean and standard deviation to measure center and spread and then estimate the percentage of the lot that is within, PWL, or outside of, PD, the specification limits. Since PD and PWL can easily be converted to one another simply by subtracting from 100, they are equivalent quality measures. The preference on which of the two quality measures to use, PWL or PD, is typically based on the

department's preference to highlight how much of the material meets the requirements as described with PWL, rather than how much is defective as described with PD.

15. **What quality measures are not recommended?**

- a. The average deviation from the target value should not be used as the quality measure for QA acceptance plans. This approach often encourages the contractor to manipulate its process during the production of a lot. In effect, the contractor increases process variability by making frequent adjustments to the process in order to get the average of the test results to be at or near the target value.
- b. The average absolute deviation (AAD) from the target value should not be used as the quality measure for QA acceptance plans. To avoid the problem of over-adjusting the process in response to early test results, the average absolute deviation from the target has been used instead of the average deviation. By taking the absolute value of the deviation from the target, the contractor cannot benefit by any strategy other than aiming for the target value. However, the variability of the material may not be adequately measured. Very different sets of test results can give identical AAD values. Not only must it be questioned if equal pay is appropriate for these widely different conditions, the use of AAD fails to document these differences that should be used for future modifications of the specification. Specifically, the means and populations may vary considerably for different sets of test results that can give identical AAD values. These mean and variability differences are disregarded with acceptance based on AAD.
- c. The conformal index (CI) should not be used as the quality measure for QA acceptance plans. The CI is very similar in practice to the AAD and has the same disadvantages of not being appropriate for a one-sided specification and potentially having the same CI value for very different test results.
- d. The moving average should not be used as the quality measure for QA acceptance plans. The moving average was developed as a QC measure and not developed for use as an acceptance approach. The use of the moving average is not consistent with the use of lot-by-lot acceptance. When acceptance is based on a lot, it is assumed that the various lots are independent of one another. Since each individual test result appears in several moving average calculations, the moving averages are correlated and the results of one average are not independent of the next; therefore, it is difficult to determine when or where a lot begins or ends. In addition, it is not easy to determine pay factors on a lot-by-lot basis since the successive moving averages are correlated and individual lots are not well defined. As a result, acceptance procedures based on moving averages often result in production shut downs and plant adjustments rather than determining appropriate pay factors for specific production lots.

16. **What are contractor and department risks?**

- a. The two types of risks discussed in this section are the seller's (contractor) risk (α) and the buyer's (department) risk (β). The acceptable level of α and β risks is a subjective decision that can vary from department to department. A properly developed QA acceptance plan takes these risks into consideration in a manner that is fair to both the department and contractor. Too large a risk for either party undermines credibility.
 - (1) Table 1 of the AASHTO Material's Specification R 9-97(2000), "Acceptance Sampling Plans for Highway Construction" (see paragraph 18d), has suggestions for risk levels for both the seller and buyer that range from 0.001 (0.1 percent) to 0.200 (20 percent). It should be noted that large sample quantities, on the order of 10 to 20 or more, are needed to achieve some of the risk levels provided in this table. Larger sample quantities will provide this lower level of risk to both the department and contractor. The selection of the number of samples required by a department may need to be modified based on an analysis of risks.
 - (2) The sample size is the number of test results used to judge the quality of a lot, and therefore it is directly related to the lot size. One reason to use larger lot sizes is the potential resultant increase in sample size. This tends to provide a much lower level of risk to both the contractor and department. However, an assumption that all of the material and construction processes remain consistent throughout the lot is required. Small lot sizes may not be compatible with large sample sizes due to a large amount of required testing. Larger sample sizes can be used with large lot sizes to decrease risks of making incorrect acceptance decisions. However, the possibility of combining materials from different populations must be taken into consideration. The final decision regarding sample size per lot cannot be made until an evaluation of risks has been completed. An attempt should be made to balance the risk between the contractor and

department while holding the risk to a reasonable level. This means that a large number of samples may be required. If the risks cannot be held to a reasonable level for both, the department may have to accept a disproportionate level of risk.

- b. The α and β risks are very narrowly defined to occur at only two specific quality levels. The α risk is the probability of rejecting material that is exactly at the acceptable quality level (AQL), while β is the probability of accepting material that is exactly at the rejectable quality level (RQL). Therefore, they do not provide a very good indication of the risks over a wide range of possible quality levels that a contractor may operate. It is necessary to construct an OC curve that illustrates the probability of acceptance for any quality level for the acceptance plan under consideration (see [Figure 3](#)) to evaluate how the acceptance plan will actually perform in practice. Another step that is necessary to fully evaluate the risks for a pay adjustment acceptance plan is to plot OC curves associated with receiving various pay factors (see [Figure 4](#)).
- c. The concept of α and β risks derives from statistical hypothesis testing where there is either a right or wrong decision. When α and β risks are applied to materials or construction, they are only truly appropriate for the case of a pass/fail or accept/reject decision. This may lead to considerable confusion if an attempt is made to apply them to the pay adjustment case.
 - (1) The evaluation of risks becomes more complicated when the acceptance system includes pay adjustment provisions. The α and β risks discussed do not fully incorporate the concept of pay adjustments. By itself, the α risk, defined as the probability that an acceptance plan will incorrectly reject acceptable quality material or construction, cannot reflect the fact that the material or construction may be accepted at any of the possible pay adjustments (full pay, increased or decreased pay). When working with a pay adjustment system, the contractor's risk may also be interpreted as the probability of acceptable material or construction being accepted at less than 100 percent pay. In order to avoid confusion in the terms when the contractor's risk is used in this manner, the risk is here called α_{100} . However, it is computed in the same manner as α at the AQL. In addition, the β risk, defined as the probability that the owner incorrectly accepts rejectable quality material or construction, cannot reflect the impact of pay adjustments on determining the department's risk. When working with a pay adjustment plan, the department's risk may also be interpreted as the probability of accepting rejectable quality material or construction at 100 percent pay or greater. In order to avoid confusion in the terms when the department's risk is used in this manner, it is here called β_{100} . There are α and β type risks (α_{PF} and β_{PF}) associated with any given level of pay adjustment or pay factor (PF) from zero through the bonus chosen by the STD. For example, at a pay factor of 0.90 (90 percent payment) the alpha and beta risks can be represented by α_{90} and β_{90} . Likewise, at a pay factor of 1.05 (bonus of 5 percent) alpha and beta can be represented by α_{105} and β_{105} .
 - (2) The use of α and β risks alone to evaluate pay adjustment acceptance plans is simply not sufficient. When developing a pay adjustment system the contractor's risk α_{PF} and the department's risk β_{PF} must also be considered for the entire range of risks associated with the system. If only one level of risk is evaluated alone, for example at 100 percent pay, some other risks associated with the system may be too high. Making any change to the system will change all risks involved.
- d. An additional method to properly evaluate the risks when pay adjustments are added to the acceptance decision is the expected pay (EP) curve (see [Figure 5](#)). The EP curve has the advantage of combining all of the possible levels into a single expected or long-term average pay for each given level of quality.
- e. The EP curve can also be used to ensure that a department's acceptance plan will pay 100 percent for material that is accepted at the AQL. It is generally agreed that the average pay for AQL material should be 100 percent. An average pay of 100 percent cannot be achieved unless a bonus is allowed. If the department's pay equations or tables are not properly developed, the average pay factor may be above or below 100 percent at the AQL. This would result in the contractor either being underpaid or overpaid on average. If this is the case, the department should determine if an expected pay other than 100 percent is acceptable for AQL material.
- f. While the average expected pay shown with an EP curve should be used in addition to considering α and β type risks, the use of EP curves alone is also not sufficient to fully evaluate an acceptance plan. The EP alone is not a complete measure of the likelihood that any individual lot will receive a correct pay factor. The variability of the individual pay factors about the EP curve must also be considered.

- g. When a price adjustment acceptance plan is used, it is essential that the department develop an EP curve and multiple OC curves for the probability of receiving various pay factors over the total range of quality levels in addition to considering all levels of α and β type risks. Both OC and EP curves must be developed and analyzed to show how an acceptance plan was designed to function. In all cases, when pay adjustments are used in the acceptance decision, the OC curves should be constructed to confirm that the acceptance procedure is working as desired and, in particular, that the average pay factor at the AQL is 100 percent. The department may also want to look at computer simulation histograms of individual pay factors to obtain a picture of how much variability is associated with the pay factor determination.
- h. It is important to note that for PWL or PD acceptance plans, computer simulation is almost always used to develop α and β risks, OC and EP curves. The OC PLOT computer program that was developed as a part of FHWA Demonstration Project No. 89 (see paragraph 18j) is able to develop OC and EP curves, run simulations on the effect of the variability of the individual lot pay factors on the final pay factor determination, and create histograms. This program can be found on the Federal Highway Administration Office of Pavement Technology website at <http://www.fhwa.dot.gov/pavement/qasoft.htm>.
17. **Are there any conflicts between American Association of State Highway and Transportation Officials (AASHTO) quality assurance publications and FHWA regulations?**
- a. The companion reports "AASHTO Implementation Manual for Quality Assurance" (see paragraph 18h) and "AASHTO Quality Assurance Guide Specification" (see paragraph 18i) were published in February 1996 as reports of the AASHTO Highway Subcommittee on Construction. The Guide Specification is not an official AASHTO Specification and the Implementation Manual is not an official guide or voluntary standard because they have not been balloted and approved by the AASHTO Standing Committee on Highways and the AASHTO Board of Directors.
- b. These reports provide uniform guidance to develop and implement quality assurance standard specifications. While these reports substantially follow 23 CFR 637B, some differences exist.
- (1) One significant difference is that the reports provide for the use of either paired split (see paragraph 11) or independent (see paragraph 10) sample data comparisons for validation of contractor test results, while 23 CFR 637B allows only independent sample data for validation (see paragraph 8). The use of a paired split sample data comparison only verifies the test procedures and equipment, not the quality of the material (see paragraph 12). The use of independently obtained and tested samples assesses material, process, sampling and testing variability. Therefore, an acceptance program that uses paired split sample comparisons or witnessed tests for validation does not ensure the material quality and does not meet the requirements or intent of 23 CFR 637B.
 - (2) On the other hand, the use of split samples in the IA program provides a check on testing equipment and procedures. This complements the QA program and ensures the credibility of the testing program. The Implementation Manual offers the option of using either split or independent samples for IA. This does not agree with the regulation that IA testing may only be performed on split samples or proficiency samples. There is value to both split and independent samples; however, they do not provide interchangeable information.
18. **Are there any reference materials on quality assurance, risks, and statistics?** Yes. The following references apply to quality assurance, risks, and statistics.
- a. "23 CFR Part 637," *Subpart B - Quality Assurance Procedures for Construction*, Federal Highway Administration, Federal Register, Washington, DC, April 2003, http://www.access.gpo.gov/nara/cfr/waisidx_03/23cfr637_03.html.
- b. "Optimal Procedures for Quality Assurance Specifications," *Publication No. FHWA-RD-02-095*, Federal Highway Administration, Washington, DC, April 2003, <http://www.tfhrc.gov/pavement/pccp/pubs/02095/>.
- c. *StatSoft, Inc., Electronic Statistics Textbook*, StatSoft, Tulsa, OK, 2003, <http://www.statsoft.com/textbook/stathome.html>.

- d. "Acceptance Sampling Plans for Highway Construction," *AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part 1B Specifications: R 9-97 (2000)*, American Association of State Highway and Transportation Officials, 22nd Edition, 2002. (This is currently being evaluated and rewritten under the guidance of NCHRP Project 20-07, Task 164.)
- e. "Definition of Terms for Specifications and Procedures," *AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part 1B Specifications: R 10-98 (2002)*, American Association of State Highway and Transportation Officials, 22nd Edition, 2002.
- f. "Glossary of Highway Quality Assurance Terms," *Transportation Research Circular No. E-C037*, Transportation Research Board, Washington, DC, April 2002, http://trb.org/news/blurb_detail.asp?id=621.
- g. *Introduction to Statistical Quality Control, Fourth Edition*, Douglas C. Montgomery, ISBN 0471316482, John Wiley & Sons, November 2000.
- h. *AASHTO Implementation Manual for Quality Assurance*, AASHTO Construction/Materials Quality Assurance Task Force of the AASHTO Highway Subcommittee on Construction, American Association of State Highway and Transportation Officials, February, 1996.
- i. *AASHTO Quality Assurance Guide Specification*, AASHTO Construction / Materials Quality Assurance Task Force of the AASHTO Highway Subcommittee on Construction, American Association of State Highway and Transportation Officials, February, 1996.
- j. "Quality Assurance Software for the Personal Computer, Demonstration Project 89," *Publication No. FHWA-SA-96-026*, Federal Highway Administration, Washington, DC, May 1996, <http://www.fhwa.dot.gov/pavement/qasoft.htm>.
- k. *Statistical Quality Control, Seventh Edition*, Eugene Grant and Richard Leavenworth, ISBN 0078443547, McGraw-Hill, January 1996.
- l. *Quality Control and Industrial Statistics, Fifth Edition*, Acheson J. Duncan, ISBN 0256035350, McGraw-Hill, October 1994.
- m. *Report on Limits of Use of Contractor Performed Sampling and Testing in Federal Highway Administration Programs*, Robert Bohman, et al, Federal Highway Administration, March 1993.
- n. *Materials Control and Acceptance - Quality Assurance*, NHI Course Number 134042A, Federal Highway Administration, National Highway Institute, <http://www.nhi.fhwa.dot.gov>.



King W. Gee
Associate Administrator for Infrastructure

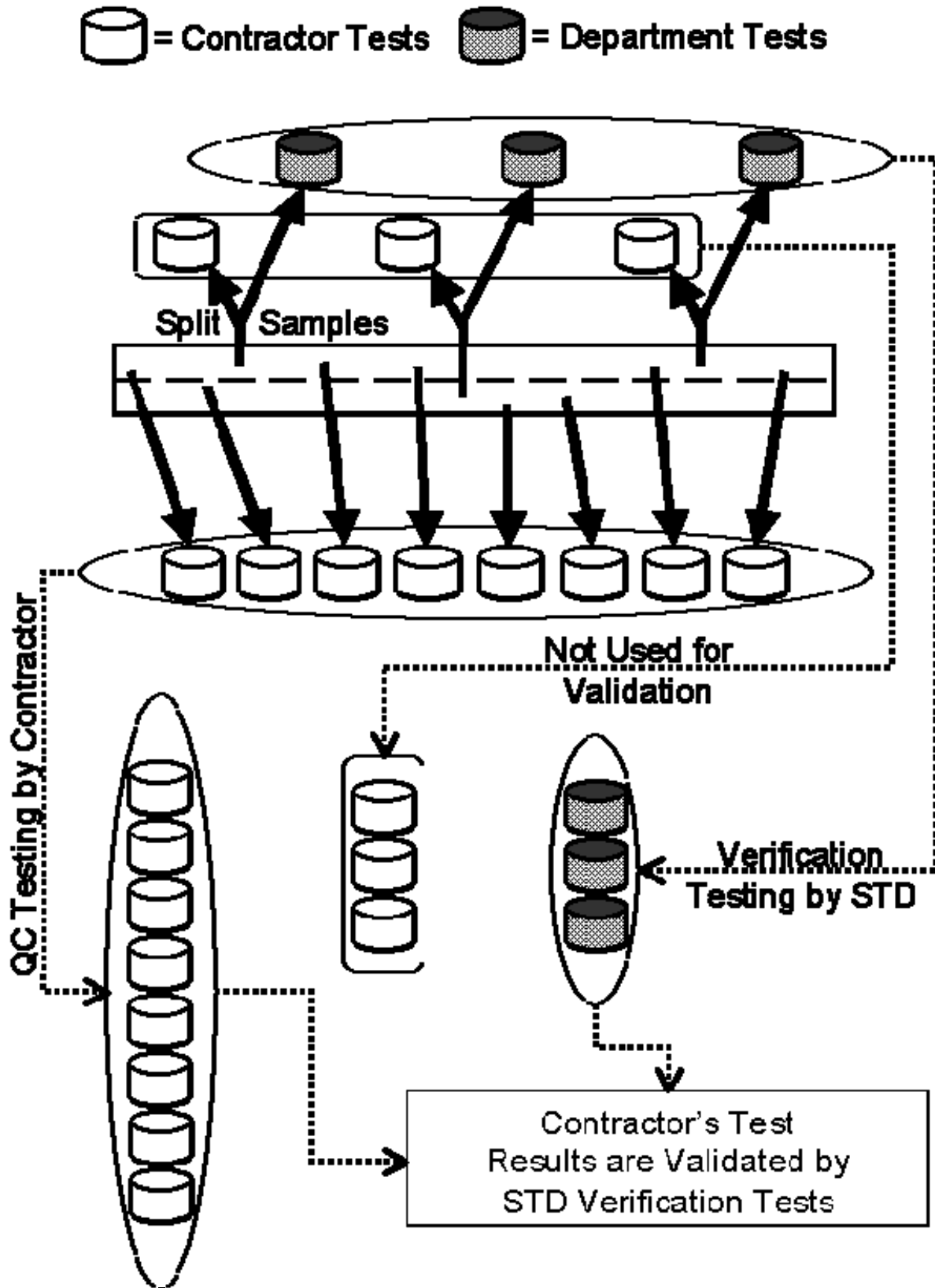


Figure 1 - Validation of Contractor's Tests

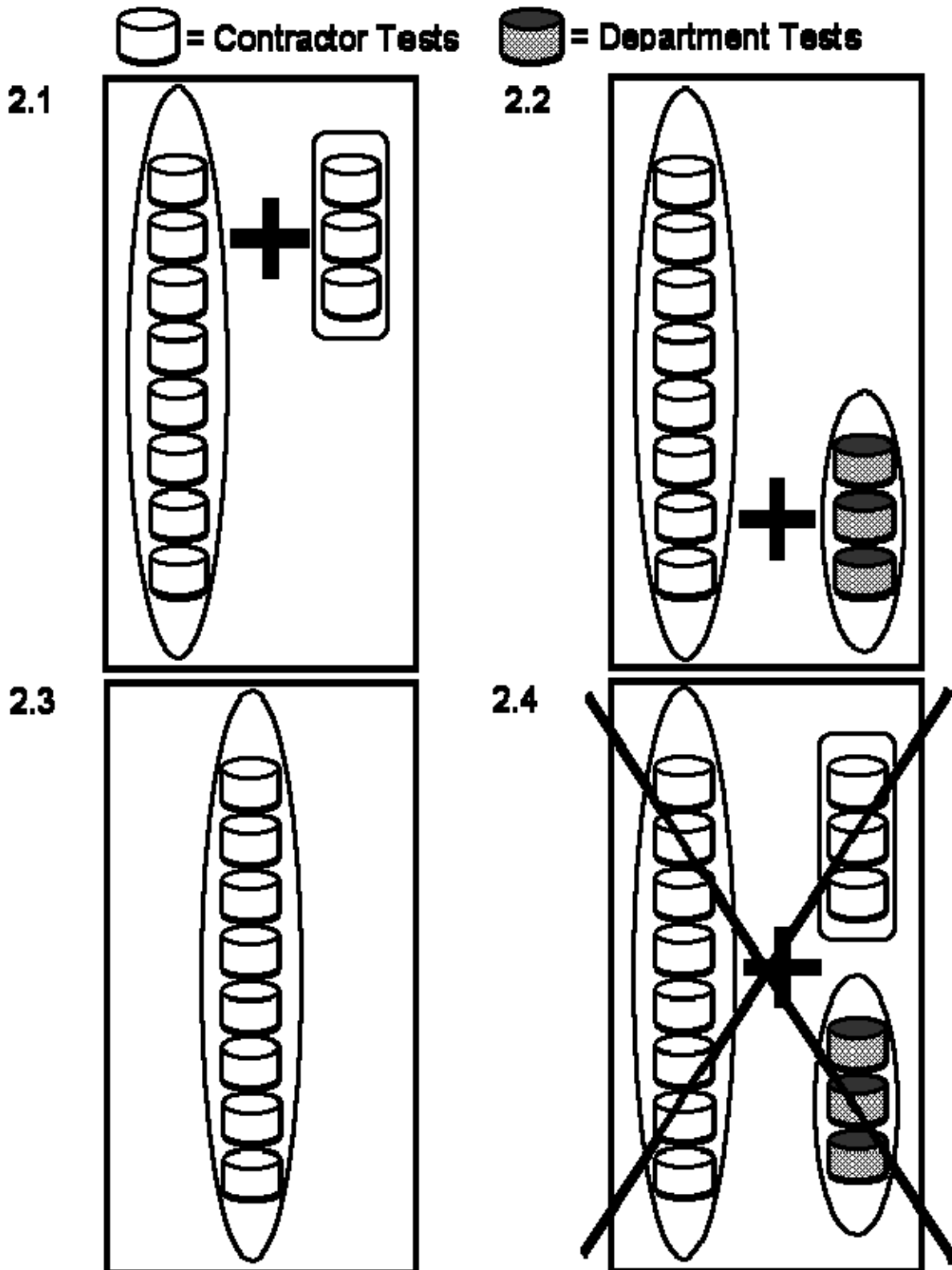


Figure 2 - Acceptance Based on Combined Test Results

(Using Sampling Plan in Figure 1)

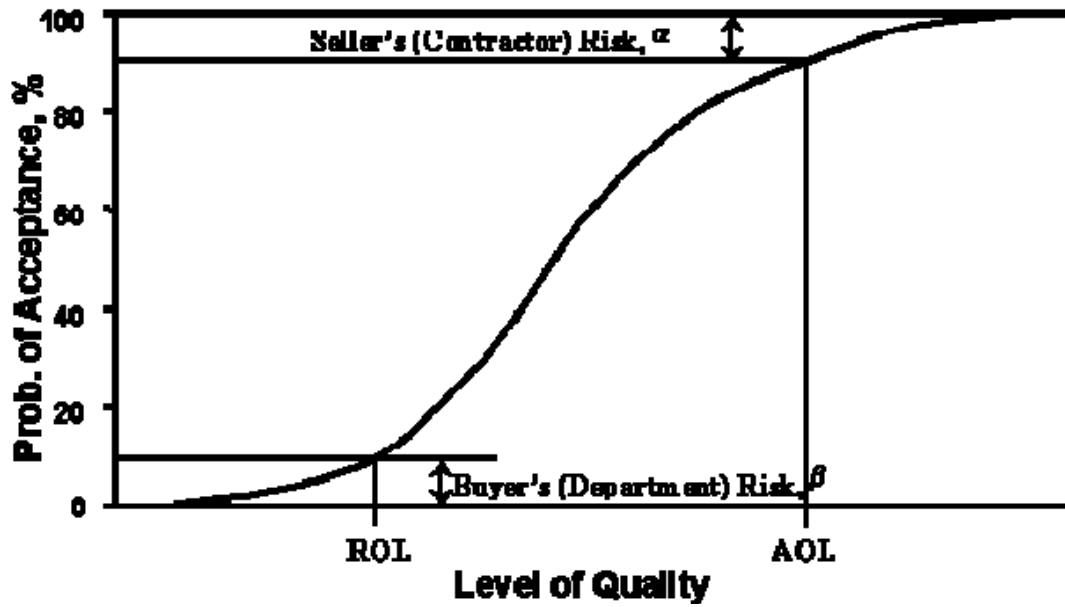


Figure 3 - Typical Operating Characteristic (OC) Curve for an Accept/Reject Acceptance

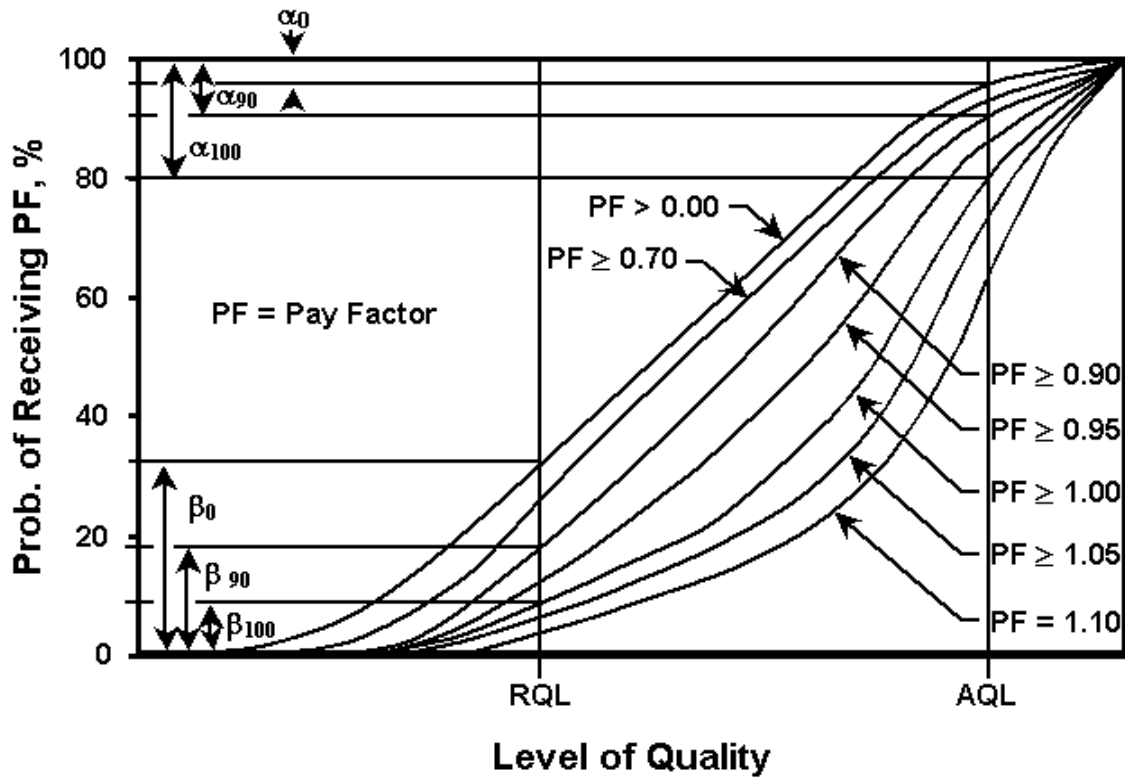


Figure 4 - Typical Operating Characteristic (OC) Curves for an Acceptance Plan with Pay Adjustments

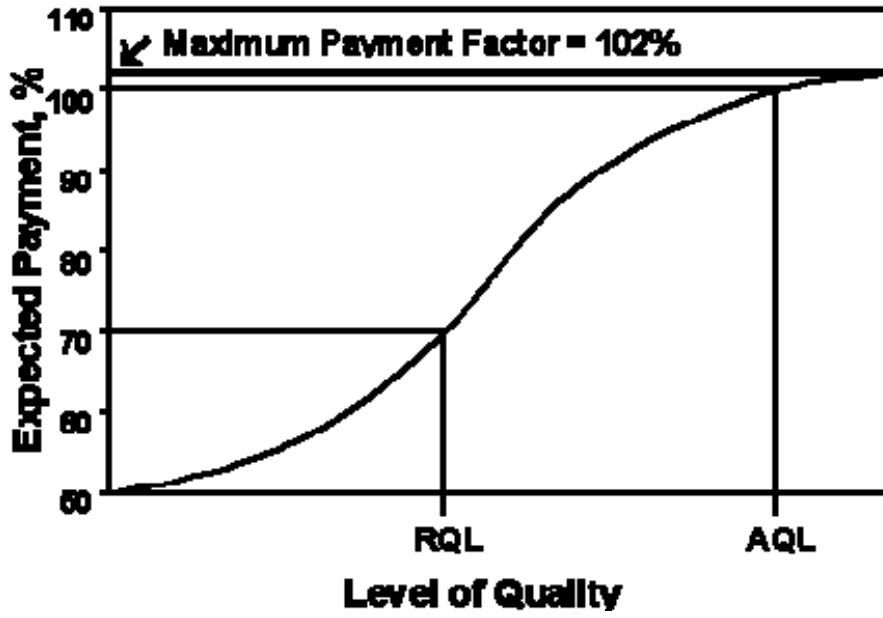


Figure 5 - Typical Expected Pay Curve

Attachment D
Federal-Aid Policy Guide
NS 23 CFR 637B

Federal-Aid Policy GuideJuly 19, 2006, [Transmittal 36](#)

NS 23 CFR 637B

Non-Regulatory Supplement

OPI: HIPT

1. **POLICY (23 CFR 637.205).** The Division Administrator shall provide appropriate oversight to ensure that the State's quality assurance program is being implemented as approved. At a minimum the oversight should cover:
 - a. Materials sampling and testing issues,
 - b. Construction inspection issues covering the specific attributes which reflect the quality of the finished product, and
 - c. State capabilities – maintaining an adequate, qualified staff to administer the quality assurance program and qualified laboratories.
2. **QUALITY ASSURANCE PROGRAM (23 CFR 637.207)**
 - a. The State's acceptance program should provide a reasonable level of inspection to adequately assess the specific attributes which reflect the quality of the finished product. Acceptance inspection should include inspection of the component materials at the time of placement or installation, as well as the workmanship and quality of the finished product.
 - b. Samples used in the acceptance decision should be taken as close as possible to where the material is incorporated into the project.
 - c. The State should retain control of the verification sampling locations and timing until immediately prior to sampling.
 - d. Sampling and testing frequencies may vary from State to State as the quality and uniformity of the material varies. The State may reduce its testing frequency for materials with a history of accurate, uniform test results that consistently meet specification requirements. The rate of testing should be higher on newly developed material sources, sources with questionable quality, sources with a wide range of test results, and sources with failing test results.
 - e. When contractor's tests are used in the acceptance decision and the State and contractor test results do not compare, the frequency of verification testing should be increased.
 - f. The State should obtain the contractor's test data as soon as it is available, no later than 24 hours after sampling is completed. The State's test results should not be given to the contractor until after the contractor results are received.
 - g. The State should review the contractor's source documentation as part of the State's quality assurance program.
 - h. Test results should not be discarded unless it is known that the sampling or testing was flawed. It may be appropriate to perform additional testing when the quality of the material is in question. However, in cases where additional tests are performed, the

acceptance and pay criteria need to be adjusted to account for the additional test results.

- i. If project materials are used in the Independent Assurance (IA) program, the IA samples should be split samples when possible, or in close proximity to the same location as the samples used in the acceptance decision.
- j. Observation of sampling and testing procedures should be included as part of an IA system to evaluate sampling and testing personnel and ensure that test procedures are performed correctly.
- k. When using the project approach for IA, the frequency should be approximately 10 percent of the frequency of the tests used in the acceptance decision.
- l. When using the system approach for IA, each inspector should be covered once or twice a year.
- m. The State is encouraged to develop a Qualified Products List for manufactured materials.
- n. The State is encouraged to perform a risk analysis when developing an acceptance program for manufactured items. When performing a risk analysis, the State should consider the use of the product, safety, cost, and historical quality of the product.
- o. The State should consider the data from the National Transportation Product Evaluation Program (NTPEP) when developing qualified product lists. See <http://www.ntpep.org/>.
- p. The State is encouraged to report the evaluation of new products to the American Association of State Highway and Transportation Officials Product Evaluation List (APEL). See <http://apel.transportation.org/>.
- q. The State should consider visual inspection and/or the manufacturer's certification as a basis for accepting small quantities of non-critical material.

3. LABORATORY AND SAMPLING AND TESTING PERSONNEL QUALIFICATION (23 CFR 637.209)

- a. All test procedures used in the acceptance decision should be in the scope of accreditation for the States central laboratory.
- b. The National Cooperation for Laboratory Accreditation (NACLA) "Recognition Procedure" and the National Institute of Standards and Technology (NIST) Interagency Report 7012 (NISTIR 7012), "Technical Requirements for Construction Materials Testing", is the criteria required for the approval of comparable laboratory accreditation programs as indicated in a Notice in the Federal Register on September 22, 2004. The accreditation bodies will be evaluated against the NACLA Recognition Procedure and the Technical Requirements for Construction Materials Testing, and they must be recognized by NACLA with the Technical Requirements for Construction Materials Testing listed within its scope before the accreditation bodies will be approved by the Federal Highway Administration (FHWA). To meet the quality assurance requirements in 23 CFR 637.209(a)(2), (3), and (4), the laboratories' scope of accreditation must indicate that the laboratory was assessed according to the requirements in NISTIR 7012. The NACLA Recognition Procedure is available at <http://www.nacla.net/Pdf/Evaluation%20Procedure%20RevA.pdf>. The Technical Requirements for Construction Materials Testing is available at <http://ts.nist.gov/ts/htdocs/210/gsig/pubs/ir7012.pdf>.
- c. The following should be used as guidance for reviewing and revising laboratory qualification programs for non-accredited laboratories that provide test results and

information used in the acceptance decision:

1. (1) **Personnel**
 - a. (a) **Supervisors.** Supervisors of testing personnel should have a minimum of 3 years experience in testing of highway construction materials.
 - b. (b) **Technicians.** Guidance for technician qualification programs is listed in paragraph 3d.
 2. (2) **Documentation.** State DOT's should develop test procedures and/or test manuals referencing standard testing procedures. These procedures should also cover handling, identification, conditioning, storage, retention and disposal of test samples.
 3. (3) **Proficiency In Testing.** Testing personnel should be routinely evaluated by observations and split samples or proficiency samples.
 4. (4) **Frequency of Assessments**
 - a. (a) Laboratory assessments should be made on a 3- to 5-year cycle.
 - b. (b) Data from the IA program along with observations during IA tests should be used as part of the ongoing evaluation of the laboratory.
- d. The following should be used as guidance for reviewing and revising a technician qualification program:
1. (1) Formal training of personnel including all sampling and testing procedures with instructions on the importance of proper procedures and the significance of test results.
 2. (2) Hands-on training to demonstrate proficiency of all sampling and testing to be performed.
 3. (3) A period of on-the-job training with a qualified individual to assure familiarity with State DOT procedures.
 4. (4) A written examination and demonstrated proficiency of the various sampling and testing methods.
 5. (5) Requalification at 3- to 5-year intervals (data from the IA program can be used as one element of requalification).
 6. (6) A documented process for retraining or removing personnel that perform the sampling and testing procedures incorrectly.
 7. (7) The following are not appropriate criteria for achieving or maintaining qualification status: Grandfathering, the acceptance of a Professional Engineer or Engineer-in-Training certificate, or lifetime qualification.
4. **MATERIALS CERTIFICATE (23 CFR 637 APPENDIX A).** The intent of the material certification is to ensure that the quality of all materials incorporated into the project is in conformance with the plans and specifications, thus ensuring a service life equivalent to the design life. Any material represented by an acceptance test that does not meet the criteria contained in the plans and specifications is considered an exception. Exceptions should be investigated to determine if in fact the material is in reasonably close conformity with the plans and specifications.

Attachment E
Monthly and Final Material Certification Letters

Material Certification Example Letter

The intent of the material certification is to ensure that the quality of all materials incorporated into the project is in conformance with the plans and specifications, thus ensuring a service life equivalent to the design life. Any material represented by an acceptance test that does not meet the criteria contained in the plans and specifications is considered an exception. Exceptions should be investigated to determine if in fact the material is in reasonably close conformity with the plans and specifications. Nonconforming materials and workmanship will be tracked, monitored and appropriately addressed.

Submit a monthly CQAM Material Certification Letter in the FHWA Statistical Analysis Report. An example follows.

Date_____

To_____

From_____

Project No._____

RE: Monthly CQAM Material Certification

This is to certify that:

The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications.

Exceptions to the plans and specifications are as follows:

1. Description
2. Description

CQAM Signature Block



Address • Town, TX ZIP Code • Telephone

Date

Mr./Ms.

Title

FHWA Texas Division Office

300 East 8th Street

Austin, Texas 78701

Reference: Final Materials Certification Letter

Project: SH Contract No.

Federal-Aid Project No.

Dear Mr./Ms. ;

This letter is to certify:

The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and in the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications. These acceptance results were performed by the Construction Quality Assurance Firm and validated by the Owner Verification Firm. Exceptions to the plans, specifications and validation have been previously noted and reviewed by FHWA in the following Quarterly Statistical Validation Reports:

Report Number	Construction Period	Report Number	Construction Period
1	Beginning of Construction to	2	Through Quarter Ending (date)
3	Through Quarter Ending (date)	4	Through Quarter Ending (date)
5	Through Quarter Ending (date)	6	Through Quarter Ending (date)
7	Through Quarter Ending (date)	8	Through Quarter Ending (date)
9	Through Quarter Ending (date)	10	Through Quarter Ending (date)
11	Through Quarter Ending (date)	12	Through Quarter Ending (date)
13	Through Quarter Ending (date)	14	Through Quarter Ending (date)
15	Final – (date) Through (date)		

Both the Acceptance results and Validation results were evaluated by an independent assurance sampling and testing program, the results of which were submitted to FHWA by the department in the Annual Report of Independent Assurance Program Results and independent of this materials certification.

Sincerely,
 (name), P.E.
 (title)

cc:

Attachment F
I2MS 3.0 Deployment Guide

I2MS 3.0 Initial Deployment Guide

1. Definitions

- <InstallCD> The path to the installation disc or folder.
- <AppRoot> The root folder of the application.
- <VirtualDirectory> The name of the virtual path in IIS to the application.
- <AppUrl> The full URL to access I2MS from the Internet.

2. Web Server Setup

Some of these features may already be present from a previous installation. If so, reinstallation is not necessary.

1. Install IIS if not already set up, using the following components:
 - World Wide Web Service with ASP.NET
 - IIS Snap-In
 - If the project will be using FTP for external data submission, FTP Service
 - SH 130 Segments 5 & 6 does not require this feature.
2. Install .NET Framework 3.5 SP1 and 1.1 Runtime
3. Install ABCPDF .NET
 - Install from <InstallCD>\ThirdParty\ABCPDF\setup.exe
 - Run Start->ABCpdf .NET 7.0->PDFSettings
 - Enter license key in the box and click Set Key.
4. Install ChartFX 7.0 for Web Forms
 - Run <InstallCD>\ThirdParty\ChartFX 7.0\ChartFX7WebForms.exe
 - Enter the license key when prompted.
5. Install ChartFX 7.0 for Web Forms Extension Pack
 - Run <InstallCD>\ThirdParty\ChartFX 7.0\Cfx7ExtPack.exe
 - Enter the license key when prompted.

3. Database Setup

1. Rename the existing Seg56_I2MS database to Seg56_I2MS_2_5.
2. Database installer for required database: Seg56_I2MS are located on <InstallCD>\Databases. Execute Seg56_I2MS.exe. Provide connection information to the database server when provided. Select the "Make a database" option and click "Advanced". Choose folders for the database and log files if not using the default. Select OK, then Run.
3. Configure mixed-mode user security for the database. The database user created should belong to the db_owner role or have the equivalent rights within the database.

4. Have a DBA execute the migration script `Migrate_Seg56_I2MS_to_3_0.sql` located in `<InstallCD>\Databases`.

4. Application Installation

1. Create a folder on the web server to serve as the root of the web application and related services. This folder can be named anything the installing organization feels is appropriate. It is recommended **not** to place it in any folder that is already accessible from the web (e.g. `wwwroot`) as some of the support folders that will be installed here contain private data. This folder will be referred to from now on as `<AppRoot>`.
2. Copy the contents of `<InstallCD>\I2MS` to `<AppRoot>`.
3. Grant Full Control access rights to the ASPNET user on the local server to the following folders under `<AppRoot>\Web Apps\I2MS` :
 - o Log
 - o MyReports
 - o TempFiles
4. Ensure that the ASPNET user has at least Read access to all other folders in the `<AppRoot>` folder structure.
5. Open the IIS configuration tool.
6. Create a virtual directory for the app, usually named "I2MS". Set the physical path to the directory as `<AppRoot>\Web Apps\I2MS\wwwroot`. Set permissions to Read and Run Scripts.
7. Edit the properties for the I2MS virtual directory in IIS.
 - o On the ASP.NET tab, make sure ASP.NET version is set to 2.0.50727.
 - o On the Documents tab, add "Default.aspx" as the first Default Document and ensure that Enable Default Document (or Enable Default Content Page) is checked.
 - o If there is no Application under the Virtual Directory tab, click the Create Button and label it I2MS. Set Execute Permissions to Scripts Only.
8. Configure the site as necessary to resolve the official `<AppUrl>` to the virtual directory.
9. Ensure that an SSL certificate is installed and that secure communication is required to access the application. If using a self-signed certificate, the certificate issuer must be trusted by the web server or Web Form Print View will not function correctly.
10. Install the I2MS Reporting and Analysis Service (Windows Service) by executing `<AppRoot>\Applications\Services\I2MS Reporting and Analysis Service\install.cmd`
11. Ensure that the I2MS Reporting and Analysis Service is set to Automatic startup but do not start it at this time. Copy any settings for automatic restart, etc. from the HB EManagers Reporting Service that was used as part of I2MS 2.0.

5. Configuration File Modification

5.1 Web Applications

5.1.1 <AppRoot>\Web Apps\I2MS\wwwroot\web.config

1. Under element <connectionStrings>, find element <add name="I2MS" />. Change the value of attribute *connectionString* to a valid connection string for the I2MS database.
2. Change the value attributes for the following keys under tag <appSettings>:
 - o base_path : <AppRoot>\Web Apps\I2MS
 - o report_path : <AppRoot>\Web Apps\I2MS\ReportFiles
 - o temp_path : <AppRoot>\Web Apps\I2MS\TempFiles
 - o report_service_filestore_path : <AppRoot>\Web Apps\I2MS\MyReports
 - o log_file_location : <AppRoot>\Web Apps\I2MS\Log\I2MS
 - o base_url : <AppUrl>
 - o debug_mode: false
 - o WebFormPrinter_WebFormServeUrl : <AppUrl>/I2MS/WebFormServe.aspx
 - o rule_bin_path : <AppRoot>\Libraries\Txdot.I2ms.Rules.Seg56\bin\Release\
 - o WebFormPrinter_User: I2MSPrintView
 - o WebFormPrinter_Password : 1Spring\$ (Change if a different password is configured for the I2MSPrintView user.)
3. Change attributes for the following elements:

```
<mailSettings>
  <smtp deliveryMethod="Network" from="admin@dummys.com (Display Name)">
    <network host="localhost" defaultCredentials="true"/>
  </smtp>
</mailSettings></system.net>
```

- o Change *from* to an email address you would prefer system generated emails to appear from.
- o Change *host* to a valid SMTP server for the network.

<AppRoot>\Applications\Services\I2MS Reporting and Analysis Service\I2MS Reporting and Analysis Service.config

1. Under element <connectionStrings>, find element <add name="I2MS" />. Change the value of attribute *connectionString* to a valid connection string for the I2MS database.
2. Change the value attributes for the following keys under tag <appSettings>:
 - a. base_path : <AppRoot>\Web Apps\I2MS
 - b. report_path : <AppRoot>\Web Apps\I2MS\ReportFiles
 - c. temp_path : <AppRoot>\Web Apps\I2MS\TempFiles
 - d. report_service_filestore_path : <AppRoot>\Web Apps\I2MS\MyReports

- e. log_file_location : <AppRoot>\Web Apps\I2MS\Log\I2MS Reporting and Analysis Service
 - f. base_url : <AppUrl>
3. Add the following XML element to the configuration file anywhere under the <appSettings> element:
- ```
<add key="Winnovative.ExcelLib_LicenseKey" value="dV5HVUZEUVJCRVVEW0VVRkRbREdbTExMTA==" />
```

## 6. First Run

1. Start the I2MS Reporting and Analysis Service.

## 7. Troubleshooting

- If HTTP 404 errors are encountered when attempting to run the application for the first time or if the ASPNET user cannot be found, ASP.NET may not be registered properly. Execute the following command to re-register:
  - %WINDIRMicrosoft.NET\Framework\v2.0.50727\aspnet\_regiis.exe -i
- If the database scripts fail with an error message about insufficient size for the model database, record the necessary size from the error message and enter it in “Database size (MB)” in the Advanced dialog of the database installer before running the installer again.

## 8. Uninstallation Procedure

If the installation of I2MS fails or it is necessary to uninstall the program, perform the following:

1. Remove the I2MS virtual directory in IIS.
2. Remove the Reporting Service by executing <AppRoot>\Applications\Services\I2MS Reporting and Analysis Service\uninstall.cmd
3. Delete the entire contents of <AppRoot>.
4. Remove the Seg56\_I2MS databases.
5. Uninstall any third party software that was installed by using each package’s uninstaller found in (Add/Remove Programs -or- Programs and Features).



**Attachment G**  
**Examples of Contract Language for Amendments and Developer  
Furnished Documentation for Off-Site Inspection and Testing Services  
Provided by TxDOT**

## Examples of Attachments for Amendments and Developer Furnished Documentation for Off-Site Inspection and Testing Services Provided by TxDOT

**An example of typical contract language for an Amendment is provided below when using TxDOT off-site inspection services.**

“As may be requested by the Developer and agreed upon by TxDOT, the cooperative use of TxDOT resources for material testing and inspection services at points in Texas where the State routinely provides resident inspection services for its own highway materials and at other locations throughout the contiguous United States will be accepted. The *[insert Agency name]* may enter into an Interlocal Agreement with the TxDOT to provide for such services.

Upon election by the Developer to use TxDOT services, the Developer shall prepare and complete Form SMRI-1 (see Figure 1) as soon as practical. This Form includes the information necessary for inspection planning and scheduling. Submit this Form to CSTM&P (Structural Group).

During construction, the Developer will need to issue a Work Request (see Figure 2) to TxDOT identifying elements of work that will require TxDOT off-site fabrication and inspection. At least two weeks prior to fabrication, work requests must be issued by the Developer to TxDOT for execution. Each work request will include the following information. A supplemental work order will be required when changes are made to the work request.

1. Project Information (i.e. contract number, project control numbers, etc.).
2. Work Description.
3. Type and quantity of highway material(s) to be tested and/or inspected.
4. Assigned fabrication for each highway material including: the fabricator's location, contact, and phone number.
5. Date inspection should occur.
6. Signature and telephone number of authorized Developer's representatives.

Prior to TxDOT personnel performing material testing or inspection services, the Developer shall provide TxDOT's Construction Division – Material and Pavement Section (CST/M&P) with one (1) copy of the appropriate design documents, including plans, special provisions, supplemental specifications, and notes. Also, the Developer shall provide a minimum of two (2) sets of approved shop drawings to the fabricators location, one of which is specifically to be stamped “For TxDOT Use”.

The Developer acknowledges that TxDOT reserves the right to perform testing services in accordance with the following criteria:

1. Availability of TxDOT's personnel to perform the necessary testing.

2. When testing will not encumber testing performed by TxDOT for State projects.
3. The right to reschedule the testing and inspection when it is determined by TxDOT that the originally scheduled time for testing and inspection of highway materials interferes with the testing and inspection for State projects.

The Developer is responsible for coordinating the scheduling of all TxDOT testing and inspections with the CQAF. If TxDOT cannot perform the inspection service, the Developer shall use its own resources to provide the required services in a timely manner. Election to use and rely upon TxDOT services is at the Developer's own option and risk. No time extension or additional compensation will be granted for issues arising from the use of TxDOT resources."

The Developer shall be responsible for all direct and indirect costs or expenses involved in the performance of TxDOT's services.

## Example of TxDOT Form SMRI-1

FORMSMRI-1 (6-10)						
<b>Structural Materials Requiring Inspection</b>					Date:	
Entity:		Project Info. (Identification):			Contact (Name/PH#):	
Bid Item	Bid Item Description	Materials Inspected for the Bid Item	Unit	Qty.	Fabricator	Comments
368	<b>Concrete Pavement Terminals</b>	Wide Flange Terminal Anchor Beams <i>*Please furnish quantity in lbs.</i>	LB			
407	<b>Steel Piling</b>	Steel Piling (H & Sheet)	SF			
409	<b>Prestressed Concrete Piling</b>	Prestressed Concrete Piling	LF			
420	<b>Concrete Structures (Precast)</b>	Precast Concrete Arch or C-Span	LF			
422	<b>Reinforced Concrete Slab</b>	Prestressed/Precast Concrete Panels (Deck Panels)	SF			
423	<b>Retaining Walls</b>	Precast Wall Panels	SF			
		Precast Coping	LF			
425	<b>Precast Prestressed Concrete Structural Members</b>	Beams - Tee, Slab, I, Trap, Box & U-Beams	LF			
		Elastomeric Bearings (Laminated, Plain, Sliding)	EA			
		Elastomeric Laminated Bearing Assembly	EA			
434	<b>Elastomeric Bridge Bearings</b>	Elastomeric Bearing Steel Assembly <i>*Generally, laminated, plain and sliding bearings are subsidiary to the beams.</i>	EA			
442	<b>Metal for Structures</b>	Miscellaneous Steel	LB			
		Structural Steel Bridge Girders	LB			
450	<b>Railing (Steel)</b>	Fabricated Handrail (Bridge Rail, Pedestrian Rail)	LF			
		Post	EA			
		Tube	LF			
454	<b>Bridge Expansion Joints</b>	Sealed Expansion Joints and Armor Joints	LF			
462	<b>Concrete Box Culverts and Storm Drains</b>	Precast Concrete Box Culverts	LF			
466	<b>Headwalls and Wingwalls</b>	Precast Headwalls	EA			
514	<b>Permanent Concrete Traffic Barrier</b>	Precast Concrete Traffic Barrier	LF			
610	<b>Roadway Illumination Assemblies</b>	Steel Poles	EA			
		Anchor Bolts	EA			
		Transformer Bases	EA			
613	<b>High Mast Illumination Poles</b>	Steel Poles	EA			
		Anchor Bolts	EA			
614	<b>High Mast Illumination Assemblies</b>	High Mast Illumination Rings	EA			
0636, 0644, or 680	<b>Aluminum Signs (Bid or Non-bid)</b>	Aluminum Signs <i>*636 Signs are LRSS and OSS signs. *644 Signs are small roadside signs only &amp; possible misc. steel for bridge mounted sign post. *680 Signs are street signs &amp; regulatory signs only.</i>	SF			
647	<b>Large Roadside Sign Supports and Assemblies (LRSS)</b>	Large Roadside Sign Supports	LB			
650	<b>Overhead Sign Supports (OSS)</b>	Overhead Sign Supports <i>*This material is invoiced as Overhead Sign Support Bridges</i>	EA			
		Anchor Bolts	EA			
686	<b>Traffic Signal Pole Assemblies (Steel)</b>	Mast Arms	EA			
		Steel Poles	EA			
		Anchor Bolts	EA			
<b>Special Specifications (numbered as determined by the Entity)</b>						
????	<b>Disc/Pot Bearings</b>	Depends on bearing type	EA			

## Work Request Example

Your Letterhead Here

---

**TEXAS TRANSPORTATION PEOPLE**

← Indicate date

**August 2, 2008**

Ms. Miranda Unruh  
TxDOT - Construction Division  
Materials & Pavements Section  
125 East 11<sup>th</sup> Street  
Austin, Texas 78701-2483

Type in the information below to include the hwy number, Project Limits, Project Number, CSJ number.

Re: **FM 1111**  
**Project Limits: from 0.2 miles West of FM 2222 to 0.46 miles East of SH 333**  
**Bobby County Project No. 2007-0028**  
**CSJ No. 0001-02-003**  
**WORK REQUEST #32** ← The work request number is a unique sequential number.

Dear Ms Unruh,

We are requesting fabrication inspection of the following materials:

← Indicate the bid item and item description(s) with estimated quantity (must include descriptions of box culverts, poles, beams, etc.)

**Item 450-2025**  
**Railing PRI (150 LF)**

The fabricator:

← Indicate one fabricator with location per work authorization for item(s) indicated above. Note: one fabricator can fabricate multiple items.

**Mr. Fabricator**  
**321 Pine**  
**Houston, TX 77018**  
**Contact Person: David Smith (off - 713-333-5555)(fax - 713-333-4444)**

The date of the inspection:

← Indicate the anticipated date material is ready for inspection.

**As soon as Structural is available, Supplier is ready for inspection.**

If you have any questions concerning this matter, please feel free to call me at **444.444.4444**.

Sincerely, ← indicate your phone number

**BOBBY COUNTY TRANSPORTATION PROGRAM**

← Signature of contact person of Entity

**Some Guy, P.E.**  
**Construction Manager**

← Each work authorization should have attachments to include pertinent plan sheets, specs, special specs, shop drawings (if required), general notes, special provisions, etc. (all sent electronic as a pdf)

**Attachments**  
cc: [File](#)

**Attachment H**  
**OVTIP Table of Contents and Earthwork Procedure**



## Owner Verification Testing & Inspection Plan

### TABLE OF CONTENTS

Procedure No.	Title	Procedure Date	Revision No.
<b>Section 1 – Program Description</b>			
D-0100	OVTIP Manual Introduction	Apr 2011	0
D-0103	Compliance with DB QAP Commitments	Apr 2011	0
<b>Section 2 – General</b>			
A-0200	List of Acronyms	Apr 2011	0
A-0203	OVTIP Manual Preparation	Apr 2011	A
A-0206	Processing and Distribution of New or Revised Procedures	Apr 2011	A
A-0227	Oversight Personnel Training and Certification	Apr 2011	A
A-0230	Sampling, Testing and Reporting Requirements	Apr 2011	A
A-0242	Audit of OVT Personnel, Equipment, and Operations	Apr 2011	A
A-0245	Review of CQAF Personnel, Equipment, and Operations	Apr 2011	A
A-0248	Statistical Analyses	Apr 2011	A
A-0249	I2MS Database Record Deletion	Apr 2011	A
A-0270	Mix Design Review	Apr 2011	A
<b>Section 3 – Construction</b>			
C-0300	Coordination of Utility Relocation Work	Apr 2011	A
C-0310	Audit of Developer Records and Operations	Apr 2011	A
C-0327	Minimum Quality Acceptance Testing Requirements	Apr 2011	A
C-0330	Hold Points	Apr 2011	A
C-0333	Construction Reporting	Apr 2011	A

Procedure No.	Title	Procedure Date	Revision No.
C-0336	Oversight of QC and QA Inspection and Testing	Apr 2011	A
C-0359	Reporting and Resolving Non-Conforming Work	Apr 2011	A
C-0360	Non-Conformance Reports	Apr 2011	A
C-0363	CQMP Review Process	Apr 2011	A
<b>Section 4 – Inspection: Earthwork</b>			
I-0400	Preparing Right-of-Way	Apr 2011	0
I-0403	Planing and Texturing Pavement	Apr 2011	0
I-0406	Removing Stabilized Base and Asphalt Pavement	Apr 2011	0
I-0409	Roadway Excavation	Apr 2011	0
I-0412	Embankment	Apr 2011	0
I-0415	Compaction	Apr 2011	0
I-0418	Subgrade Preparation	Apr 2011	0
I-0421	Surface Ditches/Grassy Swales	Apr 2011	0
I-0424	Furnishing and Placing Topsoil	Apr 2011	0
I-0427	Seeding and Sodding	Apr 2011	0
I-0430	Grading for Landscapes	Apr 2011	0
I-0433	Mulch	Apr 2011	0
I-0436	Trees, Shrubs and Ground Cover	Apr 2011	0
I-0439	Vegetation Establishment	Apr 2011	0
I-0442	Geotextiles for Vegetation Establishment / Erosion Control	Apr 2011	0
I-0445	Irrigation Systems	Apr 2011	0
<b>Section 5 – Inspection: Subbase and Base Courses</b>			
I-0500	Flexible Base	Apr 2011	0
I-0503	Treated Flexible Base	Apr 2011	0
I-0506	Subgrade Stabilization using Geotextiles / Fabric	Apr 2011	0
I-0509	Lime Treated Subgrade	Apr 2011	0
I-0512	Cement Treated Subgrade	Apr 2011	0



Procedure No.	Title	Procedure Date	Revision No.
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<b>Section 6 – Inspection: Surface Courses or Pavement</b>			
I-0600	Prime Coat, Tack Coat, Seal Coat	Apr 2011	0
I-0603	Hot-Mix Asphalt Pavement Inspection	Apr 2011	0
I-0606	Concrete Pavement Inspection	Apr 2011	0
I-0609	Concrete Pavement Joint Sealing	Apr 2011	0
I-0612	Concrete Pavement Repair	Apr 2011	0
I-0615	Concrete Pavement Crack Sealing	Apr 2011	0
I-0618	Rumble Strips	Apr 2011	0
I-0621	Asphalt and Concrete Pavement Profile Grinding	Apr 2011	0
<b>Section 7 – Inspection: Structures</b>			
I-0700	Structural Excavation	Apr 2011	0
I-0703	Structural Backfill	Apr 2011	0
I-0706	Trench Excavation Protection	Apr 2011	0
I-0709	Temporary Shoring	Apr 2011	0
I-0712	Drilled Shaft Foundations	Apr 2011	0
I-0718	Concrete Column	Apr 2011	0
I-0721	Concrete Bent Cap	Apr 2011	0
I-0724	Concrete Bridge Abutment	Apr 2011	0
I-0727	Concrete Bridge Deck	Apr 2011	0
I-0730	Concrete Barrier Rail	Apr 2011	0
I-0733	Prestressed Concrete Bridge Beams	Apr 2011	0
I-0736	Bridge Bearing Pads	Apr 2011	0
I-0738	Drilled Shaft Retaining Walls	Apr 2011	0
I-0739	MSE Concrete Wall Panels	Apr 2011	0
I-0740	Post Tensioning	Apr 2011	0
I-0742	Concrete Surface Treatment	Apr 2011	0
I-0748	Riprap	Apr 2011	0
I-0754	Painting of Structural Steel	Apr 2011	0
I-0757	Reinforcing Steel and Welded Wire Fabric	Apr 2011	0

Procedure No.	Title	Procedure Date	Revision No.
I-0760	Steel Bridge Girders	Apr 2011	0
I-0766	Sealed Expansion Joints	Apr 2011	0
I-0769	Waterproofing For Structures	Apr 2011	0
I-0772	Precast Concrete Box Culverts	Apr 2011	0
I-0775	Cast-In-Place Concrete Box Culverts	Apr 2011	0
I-0778	Reinforced Concrete Pipe	Apr 2011	0
I-0781	Miscellaneous Drainage Appurtenances	Apr 2011	0
I-0784	Removing Old Structures	Apr 2011	0
I-0785	Structural Steel Welding	Apr 2011	0
I-0786	Structural Steel Bolting	Apr 2011	0
<b>Section 8 – Inspection: Incidental Construction</b>			
I-0800	Concrete Traffic Barrier	Apr 2011	0
I-0803	Hot Mix Asphalt Plant Inspection Monitoring	Apr 2011	0
I-0806	Concrete Batch Plant Inspection Monitoring	Apr 2011	0
I-0812	Concrete Membrane Curing	Apr 2011	0
I-0813	Concrete Surface Treatment	Apr 2011	0
I-0815	Miscellaneous Concrete – Curbs, Gutters, Driveways, Sidewalks, Median Paving	Apr 2011	0
I-0818	Structure Approach Slab	Apr 2011	0
I-0821	Metal Beam Guard Fence	Apr 2011	0
I-0824	Fencing	Apr 2011	0
I-0827	Pipe Underdrains	Apr 2011	0
I-0830	Ride Quality Evaluation	Apr 2011	0
I-0833	Impact Attenuators	Apr 2011	0
I-0839	Storm Water Pollution Prevention Plan (SWP3)	Apr 2011	0
<b>Section 9 – Inspection: Lighting and Signing</b>			
I-0900	Highway Lighting	Apr 2011	0
I-0903	Power Cabling and Communication Duct Bank	Apr 2011	0
I-0906	Ground Boxes	Apr 2011	0

<b>Procedure No.</b>	<b>Title</b>	<b>Procedure Date</b>	<b>Revision No.</b>
I-0909	Electrical Inspection for Bridge Work	Apr 2011	0
I-0912	Roadside Sign Assemblies	Apr 2011	0
I-0915	Overhead Sign Structures	Apr 2011	0
I-0918	Delineators and Object Marker Assemblies	Apr 2011	0
I-0921	Temporary Traffic Control Devices	Apr 2011	0
I-0924	Permanent Pavement Markings and Markers	Apr 2011	0
I-0927	Eliminating Existing Pavement Markings and Markers	Apr 2011	0
I-0930	Traffic Signals	Apr 2011	0
<b>Section 10 – Inspection: Toll Gantries</b>			
I-1001	Toll Gantry Structures	Apr 2011	0
I-1002	Structural Steel Monotube Shop Fabrication	Apr 2011	0
<b>Appendix A – Reference Procedures</b>			

## Example of OVTIP Earthwork Procedure



### Owner Verification Testing & Plan

#### ROADWAY EXCAVATION

Procedure No. I-0409

Page 6 of 8

Revision No. 0

Original Issue: April 2011

Effective Date: April 2011

Project Name: Project Name Listed Here

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#### 6.5.1.1 PURPOSE:

This procedure describes the required OVI process related to Roadway Excavation. This operation is used to cover all roadway excavation of the required material as shown on the plans, cross sections, or as directed. This procedure covers all material encountered regardless of how the material is removed.

#### 6.5.1.2 PROCEDURES:

- 1.1 Check the Developer's schedule for times and locations for roadway excavation.
- 1.2 Review the roadway excavation requirements from the contract documents.
- 1.3 Perform daily visual inspection to verify that relevant work activities are being adequately covered by CQAF inspection/testing.
- 1.4 Verify that the Developer's relevant construction CQMP forms are completed satisfactorily and procedures are being adhered to.
- 1.5 Confirm with the CQAF inspector whether there are any soft areas in the excavation and, if so, to what extent undercutting may be required.
- 1.6 Verify with the CQAF field inspector that the excavated material is acceptable for incorporation into the project. Confirm with the inspector that unsuitable or excess material is properly disposed of in accordance with CDA requirements.
- 1.7 If a rock cut is encountered, confirm with the CQAF inspector whether it is non-homogeneous rock or homogeneous rock and if undercutting is required. Verify with CQAF inspector that approved embankment material is placed and compacted within undercut areas.
- 1.8 Verify with CQAF inspector that the field survey layouts for grade and elevation limits are correct and clearly defined.
- 1.9 For earth cuts, confirm with the CQAF inspector that finished subgrade has been scarified to a uniform depth, as defined by the contract documents, that all vegetation is removed, and that the subgrade is adequately compacted.
- 1.10 Verify that the CQAF and the Developer's surveyors confirm the plan elevation of the excavation before placement of select or embankment material.

- 1.11 Verify with CQAF inspector that drainage in the excavated areas is maintained to avoid damage to the roadway section. Confirm with CQAF inspector that subgrade damage due to inadequate drainage is corrected.
- 1.12 Determine if the roadway excavation procedures are conforming or non-conforming.
- 1.13 Non-conforming work or material which is intended to be accepted into the project will be discussed with the CQAF for resolution. An NCR shall be issued for unresolved non-conforming work or material issues in accordance with OVTIP procedure C-0360, Non-Conformance Reports.
- 1.14 Report construction inspection and testing information in accordance with OVTIP procedure C-0333, Construction Reporting.

**6.5.1.3 REFERENCES:**

- Comprehensive Development Agreement (CDA)
- TxDOT Quality Assurance Program for Design-Build Projects (DB QAP)
- Construction Quality Management Plan (CQMP)
- TxDOT Construction Contract Administration Manual
- TxDOT Manual of Testing Procedures
- TxDOT Standard Specifications for Construction of Highways, Streets and Bridges (2004)
- OVTIP manual, A-0206 Processing and Distribution of New or Revised Procedures

**6.5.1.4 FORMS:**

- OVI Daily Field Report

**6.5.1.5 REVISION HISTORY:**

Revision	Revised by:	Date Issued	Reason for Revision
0	Gregory Cleveland, P.E.	April 2011	Original Issue

**Attachment I**  
**Laboratory Certificate of Accreditation Example**

# Texas Department of Transportation

## *Certificate of Accreditation*

This is to signify that

## **ABC Laboratory**

Has demonstrated proficiency in the tests listed below and has met the minimum requirements set forth by the TxDOT Design-Build Quality Assurance Program for Construction.

Tex-101-E, 102-E, 103-E (Part I), 104-E, 105-E, 106-E, 107-E, 108-E, 110-E (Part I), 111-E, 113-E, 114-E (Part I), 115-E (Part I), 116-E, 117-E, 118-E, 120-E (Part I), 121-E (Part I), 127-E, 128-E, 129-E, 140-E, 200-F, 203-F, 204-F, 205-F, 206-F, 207-F, 208-F, 211-F, 212-F, 213-F, 217-F, 222-F, 224-F, 225-F, 226-F, 227-F, 236-F, 241-F, 242-F, 243-F, 244-F, 280-F, 400-A, 401-A, 402-A, 403-A, 404-A, 405-A, 406-A (Part I), 407-A, 408-A, 409-A, 411-A, 413-E, 414-A, 415-A, 416-A, 417-A, 418-A, 422-A, 424-A (Part II, III), 447-A, 448-A, 450-A, 460-A (Part I), 461-A, 500-C, 502-C, 530-C, 1001-S

*presented by*

Construction Division  
Texas Department of Transportation

Issue Date

Expires: Issue Date + 3 years



*Darren G. Hazlett, P.E.*

**Attachment J**  
**Technician Certificate of Qualification Example**



# Certificate of Qualification

*awarded to*

**John Doe**

The above technician meets the requirements of the TxDOT Quality Assurance Program for Design-Build Projects and is qualified to perform the following test procedures:

Tex-101-E (Part III), 110-E, 111-E, 115-E (Part I), 120-E, 121-E, 124-E, 128-E, 129-E, 140-E, 145-E, 146-E, 400-A, 401-A, 402-A, 403-A, 406-A, 409-A, 410-A, 413-A, 423-A, 450-A

*presented by*

**Construction Division  
Texas Department of Transportation**

**Expiration Date**

**Expires: Expiration Date + 3 years**

*This certificate is valid for work on any TxDOT, RMA, or NTTA project.*



**Darren G. Hazlett, P.E.**

**Attachment K**  
**Sample Letter for TxDOT Annual Report of**  
**IA Activities**

[INSERT Month, Day, Year]

J. Jeffrey Seiders, Jr., P.E.  
Director, Materials & Pavements (CSTM&P)  
Construction Division  
Texas Department of Transportation  
125 E. 11<sup>th</sup> Street  
Austin, TX 78701

RE: **Annual Report of Independent Assurance (IA) Program Results**  
[INSERT Project Name]

Dear Mr. Seiders:

In accordance with the requirements set forth in the Quality Assurance Program for Construction, the information below summarizes the results of system approach independent assurance (IA) activities conducted [INSERT by our firm if using a consultant] on the [INSERT PROJECT NAME] project for calendar year [INSERT YEAR].

Independent Assurance Program Results – [INSERT Year]	
	[INSERT PROJECT NAME]
Number of personnel evaluated by system approach IA testing	[INSERT #]
Number of IA evaluations meeting tolerance	[INSERT #]
Number of IA evaluations not meeting tolerance	[INSERT #]
Corrective actions taken: [INSERT if applicable]	

Sincerely,

[INSERT Name and Company Information]

cc: David B. Belser, CSTM&P

**Attachment L**  
**Example Audit Report**

# State Highway 130

## Audit No. 06 – LSI/CQAF Construction SWPPP and CDR, NCR and CAR processing and tracking

Contract No. 86-2XXDB5001  
Date of Audit: November 2, 2004  
Highway No. SH 130 Turnpike  
Audit No. Six (6)

Attendees/Participates: John Roberts (RKI) Mark Edwards (TT)  
John Lopacki (LSI) Howard Caldwell (TT)  
Joe Crable (TT)  
Paul Terranova (TT)  
Reggie Parker (TT)  
Carmen Merryfield (TT)

### I. GENERAL OVERVIEW

An audit of the LSI Construction Quality Assurance Firm (CQAF) and Construction Quality Control was conducted on November 2, 2004 to verify its compliance with the applicable Construction QC/QAP and SWPPP commitments. The Turnpike Team was split into three groups, SWPPP processes audited by 1) Paul Terranova and Justin Ewing (Segment 1); 2) Joe Crable and Allen Wynn (Segment 2) and CDR, NCR and CAR processing and tracking audited by 3) Carmen Merryfield and Reggie Parker.

### II. INTRODUCTION

Carmen Merryfield and Mark Edwards began the audit by welcoming the participants, describing the purpose and scope of the audit, and laying out a general plan for how the audit would take place. It was decided that the audit would be broken into the categories of SWPPP and Construction Quality Control in order to expedite the audit and minimize the time both parties would need to spend away from their project responsibilities. The CQAF agreed with the approach and the teams were split into their respective groups.

The audit was completed the same day, however no post audit meeting was held due to the unavailability of most of the earlier participants.

### III. SUMMARY OF AUDIT

#### 1. Review the SWPPP process including the implementation, enforcement, inspection, and reporting for the Storm Water Pollution Prevention Plan. Reference the EDA, Exhibit B

##### Findings:

The implementation, inspection, and reporting on the SW3P's was excellent and thorough. The SW3P's are kept in an orderly fashion in a binder in the field offices with all associated documentation including inspection reports, the Delegation of Authority letter, a copy of the TPDES Construction General Permit, Major Grading Activities Table, Construction and Waste Materials Table and a BMP Installation/Maintenance Table. All changes to the SW3P's (e.g. installation of a new BMP) are "red-lined" on the SW3P, usually within 24-hours. The ACI's are doing a good job at "rolling over" maintenance issues from previous weeks that haven't been corrected because of accessibility or additional rain. CQAF stated that priorities on the maintenance recommendations were made starting with sensitive areas and working towards less sensitive areas. This practice allows for the more sensitive areas to be maintained first and, with the amount and frequency of rain in the past year, more often. This is a good practice that fits the spirit of the SW3P.

##### Conclusion/Recommendations:

- Recommend more strict enforcement of stabilization requirements of the TPDES Construction General Permit (within 21 days of cessation of land disturbing activities). If ACI's recommendations to seed disturbed areas are not agreed to by LSI, then the issue should be escalated per LSI's Standard Operating Procedure (SOP) No. E-04. Also, an NCR should be written for flagrant violations of this requirement.
- Stabilization of stockpiles in Section 2 were said to have been through "natural re-vegetation" and no additional stabilization activities have occurred. Expecting natural re-vegetation to occur within 21 days with stockpiled topsoil is not a good practice and is not able to be documented. Recommend adhering to standard practice of seeding.
- CQAF should recommend stabilization measures in all areas where activities have ceased, not just areas where topsoil has been placed.
- The posted Notices of Intent (NOI's) located at IH-35, FM 971 and SH 29 do not have the TPDES Permit Number on them. The NOI's need to be re-posted with the number on them.
- Asphalt milling construction entrance/exits are not currently shown on the SW3P sheets. Recommend showing them on the SW3P like rock entrance/exits because it is a control to reduce dust generation and off-site vehicle tracking of sediments onto the roadway.
- Inspection reports are not always signed confirming receipt by LSI on the day prepared or the day after. This allows for disagreement about when the clock starts for the 7 day repair window allowed to meet the recommendations on the inspection forms.

- Indicate the maintenance priority areas on the inspection forms.
- The “red-lined” SW3P’s have not been scanned and entered into the CQAF document control system in several months. Recommend making copies or scanning the master SW3P into document control on a regular basis.

**Attachments:**

Environmental Commitment Checklist (pages 1 and 2) for Segments 1 and 2.

1. **Review LSI Construction Deficiency Report (CDR), Non Conformance Report (NCR), and Corrective Action Request (CAR) procedures and tracking process.**

**Findings:**

LSI is in accordance with the Quality Control procedures 715, Reporting and Resolving Nonconforming items, and 715.1, Construction Deficiency Reporting. These procedures are being followed. The audit consisted of a review of the CDR, NCR and CAR logs produced and maintained by John Lopacki, LSI QC Manager. It was found that the logs were being maintained in the office of John Lopacki in hard copy format. A random sampling of each type of non conformance report were reviewed to ensure that they were being maintained in accordance with procedures, including appropriate signatures for each instance identified and recorded on the logs. LSI is in the process of revising the QC/QAP, Procedure 715-1 and form 715.1-1, QC Construction Deficiency Report to add a QA signature block as identified earlier in the project.

**Conclusion:**

The implementation of the above-mentioned procedures, are very effective in monitoring, tracking and taking corrective action for materials or work activities found to be in non-conformance or deficient. The overall procedures are being adhered to by LSI. One issue noted; there are no electronic copies of the documents or logs being kept by LSI and these are contract deliverables which are required in both hard copy and electronic formats.