SOAH DOCKET NO. 582-15-2082
TCEQ DOCKET NO. 2015-0069-MSW

APPLICATION OF 130 ENVIRONMENTAL PARK, LLC FOR PROPOSED PERMIT NO. 2383	§ § § §	BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS

PROTESTANTS EXHIBIT 5

PREFILED TESTIMONY OF

D. LAUREN ROSS, PH. D., P.E.

ON BEHALF OF PROTESTANTS TJFA & EPICC

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I. INTRODUCTION

Q: Please state your name.

A: Debra Lauren Ross.

Q: How are you employed?

A: I am an environmental engineer and owner of Glenrose Engineering, Inc., a consulting firm.

II. QUALIFICATIONS

Q: Please describe relevant education and training.

A: I have a Bachelor of Science degree in civil engineering from the University of Texas with highest honors, awarded in 1977, a Master of Science degree in civil engineering from Colorado State University awarded in 1982, and a Doctor of Philosophy degree in civil engineering from the University of Texas awarded in 1993. My master's degree research was water and solute movement into and through unsaturated soils. My doctoral research was multivariate statistical analysis of spatially and temporally variable environmental monitoring data.

Q: Do you hold any professional licenses or certifications?

A: Yes. I am a registered professional engineer in the State of Texas.

Q: Please describe your professional experience as it is relevant to your testimony in this case.

A: I am a registered Professional Engineer in the State of Texas. I have worked as an engineer since 1977. My areas of expertise include water resources engineering, water quality protection and engineering design, groundwater transport, stormwater management, erosion and sedimentation controls, solid waste management and disposal, statistical methods, and environmental monitoring. I have served as a testifying expert in legal proceedings regarding these matters.

Q: Please identify Protestants' Exhibit 5-A.

A: It is a copy of my Resume.

Q: Is it accurate and up-to-date?

A: Yes.

Q: Do you have experience relevant to the opinions you are offering in this testimony?

A: Yes. I have been the project manager for permit applications for numerous solid waste facilities in Texas. I have also served as an expert witness in previous permit hearings for Municipal Solid Waste landfills before the Texas State Office of Administrative Hearings. I have designed and supervised subsurface investigations for solid waste facilities, and groundwater monitoring systems. I also have field and laboratory experience in the measurement of saturated and unsaturated hydraulic conductivity. I am an expert in statistical methods for environmental monitoring and have taught more than a dozen classes on the subject for graduate students and practicing professionals on that subject. I have designed facilities for stormwater management and had professional responsibility for their inspection and maintenance plans.

Q: Have you been present at the proposed landfill site?

A: Yes, I was at the site for one day on August 27, 2015. I was also present on the site for most of the days during the Applicant's supplemental subsurface investigation and the Protestants' subsurface investigation in January, February, and March 2016.

III. SUMMARY OF OPINIONS

Q: Have you developed any opinions regarding the proposal of 130 Environmental Park LLC to construct and operate a landfill at the site proposed in Caldwell County?

A: Yes.

Q: On what do you base your opinions?

A: My opinions are based upon my review of the original landfill permit application submitted the Texas Commission on Environmental Quality for 130

Environmental Park LLC, on supplemental materials produced by the applicant and obtained through discovery for this case, and on observations that I made on several visits to the site during Applicant's supplemental subsurface investigation and the Protestants' subsurface investigation in January, February, and March 2016. Protestants' Exhibit 5-R: Protestants' 2016 Field Investigation (report) describes the Protestants' fieldwork. Protestants' Exhibit 5-Q: Protestants' 2016 Field Investigation (map) is a map of the locations of Protestants' subsurface penetrations.

My opinions are also informed by publically available information regarding the site and its local and regional setting from the U.S. Geological Survey, the Texas Bureau of Economic Geology, the University of Texas, the Texas Commission on Environmental Quality, and the Texas Water Development Board. My nearly 40 years of professional experience, including work for similar experience also informs my opinions.

Q: Please summarize your opinions briefly.

A: In my opinion, the 130 Environmental Park LLC landfill permit application is based on information that fails to achieve minimum professional standards for reliability and quality control. The permit application fails to adequately characterize subsurface conditions and the potential risk of landfill leachate migration and groundwater contamination from the proposed facility. The facility would be located within the contributing watershed of Floodwater Storage Reservoir No. 21, which is under-designed for its current high-hazard rating. Furthermore, parts of the proposed landfill storm runoff management, leachate storage system and road access are proposed to be located near and/or partly within the currently effective FEMA 100-year floodplain. Uncertainties regarding floodplain modeling indicate a likely risk of inundation of parts of the landfill facility during the operational, closure, and post-closure life of the proposed landfill. These opinions and their basis is presented in the testimony below.

IV. FAILURE TO ACHIEVE MINIMUM STANDARDS FOR RELIABLE GEOTECHNICAL FIELD INVESTIGATION

Q: Does Texas Administrative Code establish minimum standards for reliable work to support a landfill permit application?

A: Yes. Texas Administrative Code establishes minimum standards relevant to work in support of a landfill permit application through three mechanisms: 1) rules regarding the practice of Professional Engineers, 2) rules regarding the practice of Professional Geoscientists, and 3) rules establishing appropriate field and laboratory sampling and analysis procedures for data submitted regarding matters under the Texas Commission on Environmental Quality (TCEQ) jurisdiction relating to permits. Additional professional standards for field investigations are established by the American Society of Testing and Materials (ASTM).

Standards Establishing the Practice of a Professional Engineer

Q: What are the relevant standards for the practice of a Professional Engineer?

A: Protestants' Exhibit 5-B is an excerpt from the State of Texas Engineering Practice Act and Rules Concerning the Practice of Engineering and Professional Engineering Licensure, Effective May 1, 2016. Section 137.63(b)(1) states: ***The engineer shall endeavor to meet all of the applicable professional practices requirements of federal, state and local statues, codes, regulations, rules, ordinances or standards in the performance of engineering services.***

Standards Establishing the Practice of a Professional Geoscientist

Q: What are the relevant standards for the practice of a Professional Geoscientist?

A: Protestants' Exhibit 5-C is a copy of Texas Administrative Code, Title 22, Part 39 §851.106. This code requires a Professional Geoscientist or Geoscience Firm to keep adequate records of geoscience services provided to the public for no less than five years following the completion and final delivery of service. Adequate records include, but are not limited to documents that have been signed and sealed or would require a signature and a seal and all relevant documentation that supports geoscientific interpretations, conclusions, and recommendations.

Original field note and records of field investigations, including subsurface penetrations, are unreproducible, uniquely significant, and essential to establish the basis, validity and interpretation of geoscientific data. They would be included as relevant documentation to support geoscientific interpretations, conclusions, and recommendations. I was first instructed regarding a professional requirement to retain all field notes indefinitely during my first undergraduate class in geology at the University of Texas at Austin in the spring of 1978.

TCEQ Standards for Records Retention and Analytical Quality Assurance and Quality Control

Q: Are there other Texas Administrative Code standards that govern professional practice regarding records retention or implementing and maintaining quality controls standards in preparing permit application information for TCEQ?

A: Yes. In addition to Texas Administrative Code (TAC) establishing standards for the practice of Professional Engineers and Geoscientists, Texas Administrative Code specifically address records retention requirements applicable to TCEQ permit applications. 30 TAC Chapter 305 Subchapter C: Application for Permit or Post Closure Order §305.47 Retention of Application Data states: "***A permittee or a recipient of a post-closure order shall keep records, through the term of the permit or order, of data used to complete the final application and any supplemental information.***"

30 TAC Chapter 330 Subchapter F: Analytical Quality Assurance and Quality Control applies to municipal solid waste facilities submitting laboratory data and analyses for use in commission decisions relating to permits. 30 TAC §330.261(b) states: "***The goal of a quality assurance (QA) and quality control (QC) program is to establish appropriate field and laboratory sampling and analysis procedures for all tested analytes to ensure proper collection, preparation, and analysis of representative samples of waste, soil, water, and other media, and evaluate completeness, correctness, and conformance or compliance of a specific data set against method, procedural, or contractual requirements. To achieve accuracy (correctness) and completeness, the owner or operator shall***

adopt acceptable data quality standards and ensure that all sample collection, preparation and analyses, and data management activities are conducted in accordance with the standards. These activities shall be reviewed regularly to ensure compliance with the standards. QC checks must be performed and corrective action taken when indicated."

ASTM Quality Assurance and Quality Control Standards

Q: In addition to standards established by Texas Administrative Code, are there other professional standards that govern the collection, storage, and management of the types of field investigation information upon which the 130 Environmental Park LLC landfill permit relies?

A: Yes. The American Society of Testing and Materials (ASTM) is an international leader in standards governing field practices. Protestants' Exhibit 5-D: ASTM D3740-12a "Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction" establishes minimum standards for field investigations such as those conducted by the applicant in 2013 and 2016. ASTM professional standards for field and laboratory testing of soil and rock used in engineering design and construction include a duty to:

- Maintain written quality requirements;
- Designate a person responsible for implementing quality system activities;
- Create and implement written standards for sample identification, storage, retention, and disposal;
- Conduct internal quality reviews with defined frequency, responsible individuals and identification of the location of resulting records; and
- Maintain a system of records that permits verification of any issued report and retention of each report and related records for at least three years.

Q: Are there other relevant ASTM standards?

A: Yes. Protestants' Exhibit 5-E is an accurate copy of ASTM D5434-12 "Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock" documents the importance of field logs: ***"the preparation of field logs provides***

documentation of field exploration procedures and findings for geotechnical, geologic, hydrogeologic, and other investigations of subsurface site conditions."

Q: Do these standards reflect ordinary and essential requirements for the reliable practice of engineering to protect public health, safety and the environment?

A: Yes. All of these procedures are ordinary and essential to develop a reliable basis for engineering design. I was taught them as part of my professional development decades ago and they are foundational aspects of my own professional practice.

Applicant's Failure to Meet Minimum Standards for Quality Assurance and Quality Control

Q: Does data submitted in the 130 Environmental Park LLC landfill permit application meet minimum standards established by the Texas Administrative Code?

A: No. Based on information presented in the application, and by witness statements under oath, data submitted in the permit application fails to meet minimum standards for professional practice in the areas of records retention and quality control established by the Texas Administrative Code. Permit data also fails to meet relevant minimum standards established by the American Society for Testing and Materials (ASTM), the recognized leader in protocols for engineering and geotechnical investigations.

Q: What is the basis for this opinion?

A: Protestants' Exhibit 5-F includes excerpts from the Oral and Videotaped Deposition of Gregory W. Adams on November 4, 2015. Page 35, lines 17 and 18 document his failure to prepare field notes. Line 23 on the same page describes a standard practice of not taking field notes. Page 39 lines 18 through 20 document a failure to prepare notes upon returning to the office. Page 40 lines 23 through 25 document the absence of a standard Biggs and Mathews Environmental practice related to either the preparation or maintenance of field notes. Page 44 lines 12 through 13 document discarding original field logs, even though these discarded logs are the basis for final logs submitted in the 310 Environmental Park landfill permit application. Page 49 lines 6 through 17 document the lack of formal or

written quality assurance procedures for log preparation, a key element to document subsurface conditions at the proposed landfill site and the potential for leachate migration. Page 54 lines 24 through 25 and page 55 line 1 document the lack of adherence to any quality control standards. Page 67 lines 11 through 17 document the failure to retain records regarding soil balance calculations.

Q: Are there other examples of Applicant's engineers failing to meet minimum quality control standards?

A: Yes. Protestants' Exhibit 5-G consists of excerpts from the Oral and Videotaped Deposition of Tyson Traw, P.E. on November 17, 2105. His testimony also documents failure to meet minimum quality control and records retention standards. Page 48 lines 9 through 19 document that Mr. Traw is not very familiar with the Biggs & Mathews document retention policy and is not sure that he complies with it. Page 29 line 25 and page 50 lines 1 through 12 document a policy to discard any information that does not support the representations included in the permit application. Page 58 line 3 documents the failure to take field notes or any documentation of site visits, even though site observations form the basis for selecting parameters used in watershed modeling for flood predictions, documented on page 89 lines 10 through 25 and page 90 lines 1 through 24. The lack of supporting documentation for flood analysis from field investigations is also documented on page 110 lines 1 through 25. Lack of any peer review process, other than ***"what do you think about this or bounce ideas off each other"*** is documented on page 132 lines 3 through 20. Lack of quality assurance and quality control procedures is documented on page 133 lines 4 through 7.

Q: Are there other examples of Applicant's professional staff failing to meet minimum quality control standards?

A: Yes. Protestants' Exhibit 5-H includes excerpts from the Oral and Videotaped Deposition of John Michael Snyder on September 21, 2015. Mr. Snyder's testimony also documents the failure of Applicant's professional staff responsible for preparing the permit application to achieve minimum quality control and record retention standards. Failure to maintain clear and written procedures

regarding the maintenance, storage and disposal of samples is documented on page 93 lines 9 through 11 and 22 through 25 and on page 94 lines 1 through 5. Destruction of field logs, which are foundational to forming the site-specific geologic framework that is an essential part of the landfill permit application, is documented on page 98 lines 1 through 7. There is abundant testimony by Applicant's witnesses that final logs submitted in the application differ from the field logs. See, for example, page 97 lines 20 through 23. There is no record, however, of what those original field logs described. Furthermore, since continuous samples were not collected in the 2013 boring investigation (see Protestants' Exhibit 5-F: Oral and Videotaped Deposition of Gregory W. Adams on November 4, 2015, page 45 lines 19 through 21 and page 46 lines1 through 5), and since Mr. Snyder and Mr. Adams each testified under oath regarding their limited participation in field work to implement the subsurface investigation, (see Protestants' Exhibit 5-F, page 35 lines 2 through 10 and Protestants' Exhibit 5-H, page 76 lines 17 through 24), they apparently did not personally observe all of the sediments that were extracted from the subsurface and that were described in the application, particularly in the boring logs, which were sealed by Mr. Snyder. The only basis for the submitted boring logs for intervals for which no samples were collected is field logs. Neither Mr. Snyder, who sealed the geology report in the application, nor Mr. Adams nor anyone else responsible for the preparation of the application, however, created field logs. The only available information for these intervals would be field logs prepared by Mr. Stamoulis. Mr. Stamoulis has testified, however, that his field role was limited to that of a field technician, not as a professional geologist. This is demonstrated in Protestants' Exhibit 5-V, which are excerpts from the Oral and Videotaped Deposition of Stefan Stamoulis on April 18, 2016, page 194, lines 13 through 18.

Q: Are there other examples of Applicant's professional staff failing to meet minimum quality control standards?

A: Yes. Protestants' Exhibit 5-H, which are excerpts of the Oral and Videotaped Deposition of John Michael Snyder on September 21, 2015 also documents the failure to have, maintain, or implement quality control procedures on page 99

lines 18 through 25 and page 100 lines 1 through 2. The lack of a document retention policy to maintain supporting documents is also documented. Page 101 lines 12 through 14 states: ***"And so the – the whole point of our document retention policy is to eliminate previous versions of things that are no longer the final form."*** This policy directly contradicts the requirement to maintain all relevant documentation that supports geoscientific interpretations, conclusion, and recommendations, as required by Texas Administrative Code regulating the practice of Professional Geoscientists. Once field logs and soil samples have been discarded, there is no data available that can be reviewed to verify the representations that are included in the materials submitted to TCEQ. Furthermore, many of those representations, such as the descriptions in the boring logs for intervals not samples, are not based on first-hand knowledge or observations.

Significance

Q: Why do these standards matter?

A: Professional practice standards are established by law to protect human health, public safety and the environment. In the context of landfill facility permitting, these standards of professional conduct and care are essential, for example, to assure complete and adequate descriptions of potential landfill leachate migration pathways, to assess whether the risk of ground or surface water contamination is properly assessed, to provide accurate information to the regulating agency, to accurately and reliably determine the extent of potential flooding, and to assess the adequacy of proposed drainage structures. During landfill construction, professional practice standards ensure accurate characterization of landfill bottom and sidewall lithology and the suitability of materials for berm and liner construction. These are just a few examples of why a professionally-defined and implemented practice of quality control and formal record retention policies and practices are an essential element of landfill permitting, construction and operation.

Furthermore, professional engineers and geoscientists are charged with a significant responsibility, when conducting site investigations for and designing regulated facilities that have the potential to place natural resources, properties, and people at risk. As professionals, we have a duty to the regulating agency and to the public, particularly those who will be most affected by our professional decisions with regard to the proposed facility. Adherence to professional standards is a basic way to assure the regulating agency and the public that the information and professional opinions that form the basis for the proposed facility are reliable and conform to professional standards of care.

Q: What are the consequences of the Applicant's failure to meet these standards in the 130 Environmental Park LLC landfill permit application?

A: There are numerous discrepancies among subsurface information and the hydrogeologic framework presented in the application and publicly available information relevant to the proposed site, results from the Applicant's 2016 supplemental boring program, and results from the Protestants' 2016 field exploration program, which I will discuss in this testimony. Without foundational field notes and records, it is difficult or impossible to identify the reasons for these discrepancies. Furthermore, there are elements of the landfill permit application that are critical to a safe and effective design for which there are no supporting field records. Boreholes during the 2013 subsurface investigation, used as a basis for the permit application geology report, were completed without continuous sampling and without an acting Professional Geoscientist in the field during their completion to observe lithology. There are no field records to form the basis for parameters used in hydrologic and hydraulic modeling to represent site vegetation and roughness in modeling existing flows and the extent of floodplains. Standard practice would be to provide either photographs or written site conditions as a basis for assumed values.

Similar Inadequate Characterization for Other Landfill Permit Applications by Applicant's Geologist: IESI TX Landfill in Jack County, Texas

Q: Are you familiar with other situations where the 130 Environmental Park LLC landfill permit applicant's engineers or geologists have failed to exercise due care in preparing a landfill permit application.

A: Yes. I am familiar with geology site characterization by Mr. Mike Snyder, P.G. for two previous landfill permit applications with inadequate and/or biased characterization of the proposed landfill sites. One such permit application was for a proposed IESI TX landfill in Jack County, Texas (Proposed Permit No. 2332).

Q: How are you familiar with Mr. Snyder's work on the IESI TX landfill permit application in Jack County?

A: I was hired to review the permit application by a group of residents who were opposing the proposed landfill permit. I provided testimony on behalf of the residents, including expert testimony regarding the inaccuracies in the description of the subsurface at the proposed site.

Q: Please describe the inaccuracies in the subsurface characterization included in that permit application that you discovered and testified about.

A: In that application the Pennsylvanian Canyon Formation was misidentified as an aquiclude. In fact, sandstone formations within this formation provide most of the potable water within the vicinity of the proposed landfill. At many locations near the proposed landfill there is no other water supply. The application also failed to identify the Strawn Group Formation, another formation near the proposed landfill site capable of providing usable groundwater.

Furthermore, the IESI TX landfill permit application identified only eight wells in the proposed landfill vicinity. My conversations with neighbors and a search of state well records identified 46 water wells within one mile of the proposed landfill boundary; and an additional 28 wells located between one and approximately two miles from the proposed boundary. By failing to identify all of the local groundwater-bearing formations underlying the proposed landfill and by

failing to identify most of the nearby wells, the IESI TX landfill permit application, prepared in part by Mr. Mike Snyder, misrepresented and diminished potential consequences from leachate migration through a failed liner system to critical local groundwater supplies. This information is documented in my prefiled testimony for SOAH Docket No. 582-08-1804, TCEQ Docket No. 2007-1302-MSW.

In that case, as in this case, I understand that field notes, field logs, and soil samples had been discarded before the protesting parties could access them.

Similar Inadequate Characterization for Other Landfill Permit Applications by Applicant's Geologist: Pintail Landfill in Waller County, Texas

Q: Is there another landfill permit application where geologists and engineers responsible for this permit have failed to reliably characterize the proposed landfill's geologic setting?

A: Yes. I have reviewed boring logs for subsurface investigation at the proposed Pintail Landfill in Waller County, Texas from four sources:

- application boring logs in Pintail LF Boring Logs & Reports.pdf;
- handwritten driller's logs in a series of emails contained in Pintail LF Drillers Logs.pdf;
- relevant data from Pintail Landfill Geotechnical Laboratory Test Summary; and
- Submitted Driller's Well Reports downloaded from http://www2.twdb.texas.gov/apps/waterdatainteractive/groundwaterdataviewer.

Like those in this case, logs for the proposed Pintail Landfill were prepared by Mr. Snyder based on a subsurface investigation implemented by Mr. Stamoulis. In that case, however, handwritten logs were available for some of the borings submitted in the landfill permit application. Submitted Driller's Well Reports were available for borings where piezometers were installed, to the depth of the bottom of the piezometer.

Despite limitations in the available data, I found differences between available handwritten driller's logs and application boring logs. For some borings the presence of clay is overstated in the application logs compared to the handwritten driller's logs. In some of the application logs, the presence of gravel or silt in the handwritten driller's logs is missing. Some of the specific differences are these:

- Application Log of Boring BME-A3 shows clay (CH) from 78 to 85 feet, where the driller's log shows sandy clay extending below 78 feet.
- Application Log of Boring BME-A5 shows clay (CH) from 67 to 71 feet. Driller's log shows sand with abundant gravel for this interval. The Submitted Driller's Well Report No. 261885 for this boring shows clay from 67 to 67.5 and ends at 67.5.
- Application Log of Boring BME-B2 describes the interval from 64 to 78 feet as clay (CH). It fails to describe "some silt," as indicated in the driller's log.
- Application Log of Boring BME-C2 shows clay (CL) from 4 to 16 feet. Driller's log shows clayey sand from 12 to 16 feet.
- Application Log of Boring BME-F2 shows clay (CL) in the interval from 12 to 18 feet. The driller's log shows silty sand from 14 to 16 feet. Geotechnical test results indicate that only 8% of a sample from this interval (sample elevation 217.5 feet) passed the #200 sieve, which is consistent with a sand sample. A sieve test or analysis is a method used by labs to assist in classifying soils.
- Application Log of Boring BME-F4 shows sand from 38 to 41 feet where the driller's log shows gravel. The Submitted Driller's Well Report No. 261843 for this boring is consistent with the driller's log.

By describing the presence of clay in permit application logs for the proposed Pintail Landfill in intervals where the handwritten logs indicate the presence of sand, silt or gravel the permit application logs indicate less of a potential for leachate migration from the proposed landfill compared to handwritten drillers logs.

V. FAILURE TO CHARACTERIZE RISKS OF LANDFILL LEACHATE MIGRATION AND GROUNDWATER CONTAMINATION

Q: Why is an accurate description of subsurface geological conditions important in a landfill permit application?

A: An accurate description of subsurface geological conditions is essential for proper design of a landfill and the associated groundwater monitoring system. Subsurface geological conditions are also key to understanding the potential risk of landfill construction and operation to adjacent ground and surface water resources. The 130 Environmental Park LLC Landfill permit application fails to accurately and completely characterize the geologic setting of the proposed site. Actual conditions at the proposed landfill site, as demonstrated by publicly available information, by information obtained by the applicant during a supplemental field investigation undertaken in response to Protestants' pending field investigation, and by information obtained by Protestants during their field investigation indicate multiple potential pathways for leachate migration that are not represented in the landfill application.

Inconsistencies between pre-existing data and their geologic framework

Q: Can you explain your understanding of the surface geology, based on your review of publicly available maps and reports?

A: Yes. Protestants' Exhibit 5-I: Proposed 130 Environmental Park LLC Landfill Mapped Geology is a map that I prepared using the U.S. Geological Survey Geologic Database of Texas, December 26, 2007 and the proposed landfill location based on the General Topographic Map, drawing IA.3, August 30, 2013 in the permit application. Protestants' Exhibit 5-I shows most of the site underlain by the Leona Formation. According to the Geologic Database of Texas, the Leona Formation forms a broad terrace of sand, clay and gravel up to 50 feet thick. Protestants' Exhibit 5-I illustrates that the Midway Group crops out under a much smaller area of the landfill footprint. The Midway Group is described by the Geologic Database of Texas as silty and sandy clay with silt and sand more abundant upward. It grades upward to mudstone and sand of the Wilcox Group.

East of the proposed landfill site, the Wilcox Group is mapped as cropping out at the surface. The Geologic Database of Texas describes the Wilcox Group as mostly mudstone with sandstone, lignite, ironstone concretions. It may include thinly bedded silt and very fine sand laminae.

This mapped location of the Wilcox Group at the surface is consistent with the location of the Texas Water Development Board's mapped l outcrop of the Carrizo-Wilcox Aquifer and the mapped presence of water wells. I have prepared Protestants' Exhibit 5-AD: Major Aquifer Outcrop in the Vicinity of the Proposed 130 Environmental Park LLC Landfill to illustrate the relationship between this mapped geology and well locations based on groundwater well information maintained by the Texas Water Development Board. These exhibits illustrate the a potential migration pathway of leachate from the proposed landfill through Leona sands and gravels, through silt or fine sand laminae of the Wilcox Group, or through silt or sand laminae or secondary fissures and fractures in the Midway Group into the Carrizo-Wilcox aquifer recharge zone and nearby water wells.

Q: What is the purpose of reviewing surface geology mapped by the U.S. Geological Survey and the Texas Bureau of Economic Geology?

A: Hydrogeology of a site is determined by geologic processes such as deposition, erosion, cementation, mineral deposition, faulting and weathering and hydrologic processes such as rainfall, recharge, spring and river flow. These processes occur on a larger scale than a single site. Professional engineers and geoscientists would first look at publicly available data to develop a conceptual model of regional geology and hydrogeology as a basis for understanding site-specific observations. This is typically the first step in a subsurface investigation— to review publicly available data.

Q: What are some of the differences between the 130 Environmental Park LLC landfill permit geologic framework and other publically available information?

A: One difference is surface geology mapped by the U.S. Geological Survey and the Texas Bureau of Economic Geology compared to the surface geology description in the application. Despite Protestant's Exhibit 5-I showing the Leona Formation

under a majority of the site, the permit application discounts the presence of the Leona formation. Page E-12 of the application states: ***"The site is located on the outcrop of the Midway Group. The Midway in the area consists primarily of dense, silty, fat clay (high plasticity inorganic clay, CH)."*** The application description of the Midway Group is also inconsistent with the description of this formation in the Geologic Database of Texas because it fails to describe the potential presence of silt and sand.

Q: How else does the description of the surface geology in the application materials differ from relevant geologic descriptions in the publicly available data that you reviewed?

A: The permit application minimizes the existence of pebbles and cobbles, describing "remnant pebbles and cobbles" as mostly being interbedded in the clay formation. The application describes the Leona as having been eroded from the site, leaving the Midway formation cropping out at the surface. In fact, however, materials observed in both the Applicant's 2016 supplemental borings and Protestants' subsurface investigation are consistent with descriptions of the mapped geology as Leona Formation.

Q: Other than the published sources you cited, did you encounter other inconsistencies regarding the description of the surface geology in the application?

A: Yes. The permit application description of surface strata as containing ***"only remnant pebbles and cobbles"*** is contradicted by other local observations. One such observation is documented in Protestants' Exhibit 5-J: Plum Creek Reservoir 21 Plan and Profile Sheets 1 through 3. This document presents boring logs in cross-sections for the Plum Creek Conservation District Reservoir No. 21 dam, located within the proposed landfill property boundary and slightly more than 1,000 yards south of the facility boundary. I have colored this exhibit to highlight intervals of clayey sand and intervals of clayey gravel. Cross-sections constructed from the borings on Protestants' Exhibit 5-J demonstrate that these intervals can be correlated among borings, indicating the presence of continuous strata.

Two additional pieces of evidence supporting the presence of gravel or cobbles beyond that described in geologic site description for the 130 Environmental Park LLC landfill permit application are contained within the wetland and archeological investigations conducted to support the landfill application. Protestants' Exhibit 5-K: Table of Application Wetland Determination Sampling Points Indicating Cobble in the Subsurface and Map, lists locations where cobbles were identified as a restrictive layer in 19 different locations at depths ranging from four to eight inches. Several of these locations are below the proposed landfill footprint and within the area characterized by the 2013 subsurface investigation.

Another piece of evidence from the application supporting the presence of gravel near the surface of the proposed landfill footprint is contained in descriptions of site archeological shovel test pits. Protestants' Exhibit 5-L is a map of archeological shovel test pits, followed by a table of summary descriptions from the permit application. All of the 42 descriptions of lithologic material in the test pits describe the presence of gravel. Many include descriptions such as: ***"with abundant gravel[,]"*** ***"with 50% gravel"*** and ***"with 80% gravel[.]"*** These descriptions by professional field investigators at the proposed landfill site stand in sharp contrast to the permit application's description of surface material in the Geology Report of only remnant pebbles and cobbles without continuous strata.

Q: Have you observed the presence of gravel or cobbles in the surface lithology at the proposed landfill site?

A: Yes. Specifically, during my site visit on August 27, 2015, I observed areas of the site with significant amounts of gravel across the surface. Those observations are documented in the photographs and map presented in Protestants' Exhibit 5-M. I also observed the presence of cobble, gravel and coarse sand at the surface of the proposed landfill site in Trenches T-1, T-2, T-3, and T-5 that were dug at my direction on February 16, 2016. The locations of these trenches are illustrated on Protestants' Exhibit 5-Q: Protestants' 2016 Field Investigation (map).

Applicant's own photos of the surface near the proposed landfill site also demonstrate significant pockets of gravel, as shown in Protestants' Exhibit 5-AB: Applicant's Photograph of Surface Gravel.

Failure to characterize the range of lithologic conditions at the site

Q: Why is it important to characterize the range of lithologic conditions at the proposed landfill site?

A: Natural subsurface conditions are inherently variable. Even in sandy porous media, groundwater moves preferentially through zones of higher conductivity. Where substantial portions of the lithology are clay, however, as represented by the application borings, identifying zones of preferential groundwater movement is even more significant than in a sandy porous media to characterize the potential rate and extent of leachate migration in the event of a liner failure. These zones of preferential groundwater movement in predominantly clay material would include gravel, silt, and sand lenses, which would be common in the transitional depositional environment at the boundary between the Midway and Wilcox formations. Identifying zones of lower plasticity, as well as secondary fracture and fissure features that are common in weathered clay formations would be key to understanding and anticipating the potential velocity and extent of landfill leachate migration, and risks of groundwater contamination.

Q: Do TCEQ standards recognize the importance of these zones of preferential groundwater movement?

A: Yes. 30 TAC §330.63(e)(4) states ***"boring logs must include a detailed description of materials encountered including any discontinuities such as fractures, fissures, slickensides, lenses, or seams."***

Q: Does the 130 Environmental Park LLC landfill permit application Geology Report and its attachments adequately, accurately and reliably characterize the proposed landfill site and its potential for leachate migration to groundwater aquifers?

A: No, they do not. The Geologic Report narrative description minimizes the presence of sand, gravel, and cobble material in Stratum I. These materials would

readily transmit leachate in the event of a breach in the landfill sidewall liner. They would also affect the suitability of these materials for liner and berm construction. Furthermore, permit application boring logs uniformly classify lithology as high-plasticity clay (CH). In other words, a review of the boring logs indicates that the subsurface of the proposed landfill is uniformly composed of high-plasticity clay, which is inconsistent with mapped geologic formations that are described as comprised of highly variable material with seams, lenses, and laminae of more permeable material. Laboratory tests on three samples from the Applicant's 2013 subsurface investigation fail to support the application presentation of a site consisting uniformly of high-plasticity clay. Based on laboratory test results for samples from BM3-28 at 13 feet, BME-29 at 13 feet, and BME-31 at 23 feet on page E5-1 of the application, material present in the subsurface at the proposed landfill site, as represented by these samples, is low-plasticity.

Boring logs submitted as part of the permit application also fail to describe secondary features as required by TCEQ rules. The submitted boring logs in the permit application, for example, fail to identify fractures, silt and sand seams, gypsum seams, and joints indicating preferential groundwater movement and weathering. See permit application Logs of Borings BME-01 through BME-32. But for supplemental borings conducted by both the Applicant and Protestants, information regarding these secondary features, which are most likely to transmit groundwater and leachate at the proposed site, would not be available in the proposed landfill permitting process. Anyone reviewing boring logs submitted with the application would be led to conclude that no secondary features exist in the subsurface of the site.

Q: Are there lithologic characteristics identified in the supplementary boring program that are not represented in the permit application?

A: Yes. In addition to three low-plasticity clay intervals not identified in the permit application logs, both the Applicant's 2016 supplementary borings and the Protestants' 2016 field investigation documented the presence of a range of materials beneath the proposed landfill facility site, including sandy silt seams,

silty sand seams, clayey sand with gravel, laminated claystone and clayey gravel. Secondary features were consistently observed in many of the sediments extracted from the boreholes. Some of the lithologic discontinuities not described in the permit application but observed during the supplemental field investigations are illustrated in the photographs in Protestants' Exhibit 5-N. The presence of these materials is also documented in Protestants' Exhibit 5-O: Summary of Laboratory Test Results for Protestants' Borings. Their presence is also documented in Applicant's Exhibit 130 EP-7, p. 9.

Q: Did the 130 Environmental Park LLC landfill permit application identify fissures or fractures in the subsurface?

A: No. There were no secondary feature fissures or fractures identified in the 32 borehole logs submitted as part of the permit application. This absence is confirmed by the prefiled testimony of Michael Snyder, P.G. on Applicant's Exhibit Snyder-1, p. 23, lines 42 through 44. Despite finding no fissures or fractures during the 2013 subsurface investigation of 2,957 feet of the subsurface, 22 fractures were observed by the Applicant in the 2016 BME borings. Fractures and fissures were also observed by the Protestants' geologist Michael Rubinov in their field program at the site. A list of fractures documented in borehole logs for both Applicant and Protestant borings is presented in Protestants' Exhibit 5-P.

Q: Is it expected, given that 22 fractures were observed in the Applicant's 2016 supplemental borings, that none would be observed in the 2013 borings?

A: Given the frequency of fractures observed in the applicant's 2016 borings, the expected number in the 2013 subsurface investigation is 105 fractures. The probability of observing no fractures during the 2013 boring program, given that both programs investigated similar lithology, is miniscule, 4×10^{-47}.

Q: Is there other evidence of differences in the lithology described in the 2013 boring logs and lithology that was observed by Protestants in their field investigation?

A: Yes. The Unified Soil Classification System classifies fine-grained lithologic material as either organic material, silt or clay, and as either high or low plasticity based on geotechnical measurements of liquid limit and plastic limit. Where all of

the 2013 samples were classified as high plasticity clay (CH), Applicant's laboratory geotechnical characterization of samples from the Applicant and Protestants' 2016 boring program, classified four samples as silt and seven as low plasticity. Based on the Protestants' laboratory characterization of samples from the Applicant's and Protestants' 2016 boring program, two samples would be classified as silt and 23 would be classified as low plasticity. These results from both the Applicant's and Protestants' geotechnical analyses demonstrate that the 2013 subsurface boring program failed to characterize the range of material present in the subsurface at the proposed landfill site.

Q: Do these differences matter to the interests of the public in siting the proposed landfill?

A: Yes. Both silt and low-plasticity materials will provide zones of preferential groundwater and leachate migration compared to highly plastic clay that was exclusively identified in the permit application based on the 2013 boring program. They represent a risk of leachate migration from the proposed landfill to adjacent areas, including the Wilcox Aquifer recharge zone, that was not characterized in the permit application.

Q: Protestants' finding of 23 low-plasticity samples is higher than the Applicant's seven low-plasticity samples. Is this difference significant?

A: The reported difference between results from the Applicant's and Protestants' laboratory analysis for samples from the same boring intervals indicates bias. Fifty-two samples from the Applicant's borings were analyzed in the laboratory by both the Applicant and by Protestants for liquid limit, plastic limit and percentage passing the No. 200 sieve. For these 52 samples, I conducted a paired Student's t-test to determine whether differences between Applicant's and Protestants' measurements of liquid limit and percentage passing the No. 200 sieve could be accounted for by normal random variability.

Q: Why did you choose this test to determine whether the differences between Applicant's and Protestants' measurements were significant?

A: An article by D. G. Altman and J. M. Bland, published in *The Statistician* in 1983 is considered a key reference on method comparison studies. Although the original research is for comparing measurements in medicine, the statistical principles are uniformly applicable and specifically relevant to the comparison of measurements by Applicant's and Protestants' laboratories. I have included a copy of this article as Protestants' Exhibit 5-AC: Measurement in Medicine: the Analysis of Method Comparison Studies and highlighted the text on page 314 recommending formal examination of zero bias by the paired Student's t-test.

Q: What were the results of your statistical analysis?

A: The results of my analysis indicate a very low probability (0.001 for liquid limit and 5.4×10^{-6} for percentage passing the No. 200 sieve) that differences between the Applicant's and Protestants' measurements are attributable to random variability. Compared to a significance level of either 95 or 99 percent, the statistical conclusion would be that results for these two measurements indicate bias. Applicant's liquid limit and the percentage passing the No. 200 sieve test results are biased high, compared to Protestants' laboratory results for the same samples. This bias would generally indicate more fine-grained samples and generally more highly plastic samples based on results from the Applicant's laboratory testing and both of these characteristics suggest that the permeability of subsurface materials would be lower.

Q: Do you have an explanation for this difference?

A: The clear implication of the differences between the two laboratories is that results for the portion of samples analyzed by Applicant's laboratory did not represent the entire sample submitted. Samples from Applicant's borings analyzed by Protestants' laboratory were derived from the remainder of original samples after Applicant's laboratory testing was complete. Three samples from BME-44 at depths of 32, 44, and 58 feet, for example, were reported by the Applicant's laboratory as 100 percent passing the No. 200 sieve. The fractions of the same samples reported by the Protestants' laboratory as passing the No. 200 sieve fraction, however, were less than 100 percent. If 100 percent of the original sample had consisted of fine-grained silts and clays that would pass the No. 200

sieve, as reported in the Applicant's laboratory test results, it would not be possible for Protestants' laboratory to construct a biased sample indicating less than 100 percent for the same analysis. The bias appears to have originated in Applicant's laboratory selection of a portion of the sample to analyze.

Inconsistent characterization of lithologic conditions based on comparisons between application logs and both Applicant supplemental and Protestants' borings.

Q: Is there additional evidence that boring logs in the permit application from the 2013 subsurface investigation failed to characterize the range of lithologic conditions at the proposed 130 Environmental Park LLC Landfill site?

A: Yes. Borings in both the Applicant's and Protestants' 2016 subsurface investigations were installed in close proximity to a few of the borings in Applicant's 2013 subsurface investigation. Protestants' Exhibit 5-Q is a map showing the location of Protestant's subsurface penetrations. Applicant's Exhibit 130EP-7, page 17 also shows some of Protestants' borehole locations in close proximity to Applicant's 2013 boreholes.

Protestants' borings IV-2 and IV-2A, for example, are in close proximity to Applicant's boring BME-7. Protestants' boring IV-3 and trench T-2 are in close proximity to Applicant's boring BME-27. Protestants' boring MP-2 is in close proximity to Applicant's boring BME-26. Protestants' borings MP-1 and MP-1A are in close proximity to Applicant's boring BME-32.

Protestants' Exhibit 5-S illustrates lithology based on laboratory characterization of samples from Protestants' adjacent borings that differs from lithology reported in the 130 Environmental Park LLC landfill permit application based on Applicant's 2013 subsurface investigation. This exhibit demonstrates that intervals characterized by the Applicant as highly plastic clay (CH) were characterized by laboratory tests of Protestants' samples as clayey sand with gravel (SC), lean clay with sand (CL), clayey gravel (GC), lean clay with sand (CL) and sandstone. These differences in lithologic characterization are significant in terms of understanding the potential for leachate migration from the

proposed landfill. They raise questions regarding the veracity of the Applicant's boring logs and characterization of the subsurface environment.

Mistakenly equating of the presence of groundwater as an adequate indication of the potential for leachate migration

Q: Does the limited occurrence of groundwater directly beneath the proposed landfill footprint, as described in the permit application, indicate there is little or no potential for groundwater or aquifer contamination from the proposed 130 Environmental Park LLC landfill?

A: No. Both the Applicant's and Protestants' subsurface investigations consistently measured groundwater at the proposed landfill's southeastern boundary, in Applicant's piezometer P-32 and Protestants' temporary piezometer MP-1. The lithology observed in boring MP-1 consists of clayey silt and cemented sandstone, which is consistent with descriptions of both the Midway and the Wilcox and are the types of material expected at the depositional interface between these two formations. Protestants' Exhibit 5-T is a map showing numerous wells completed in the Carrizo-Wilcox Aquifer, which is in close proximity to the proposed landfill footprint. The aquifer is in closest proximity at a location where the potential for leachate migration may be highest.

Q: Why is an accurate measure of hydraulic conductivity at a proposed landfill site important to the landfill permitting process?

A: Hydraulic conductivity is a measure of the subsurface capacity to transmit groundwater. It is the single best measure to indicate the potential for leachate migration to aquifers from the landfill in the event of a landfill liner failure. It is a key parameter to estimate groundwater velocities and travel times to aquifer receptors.

Q: Do Applicant's measures of hydraulic conductivity at the proposed 130 Environmental Park LLC landfill site accurately reflect the potential for leachate migration from the site?

A: No. Applicant's measures of hydraulic conductivity in the landfill permit application are summarized in Volume 4, Attachment E, page E-20. They indicate

a range of permeabilities from 1.1 x 10^{-8} centimeters per second to 5.2 x 10^{-8} centimeters per second. All of the hydraulic conductivities reported in the permit application were based on laboratory measurements. These laboratory values for hydraulic conductivity are lower than the values measured in the laboratory on samples collected during the Applicant's 2016 supplemental boring program and Protestants' subsurface investigation.

Q: Are laboratory measurements of hydraulic conductivity, without additional field tests, adequate to indicate the potential for leachate migration in the subsurface below the proposed landfill site?

A: There are several reasons why hydraulic conductivities based only on laboratory tests are insufficient to accurately reflect in-situ field conditions and the potential for leachate migration from the proposed landfill site. Hydraulic conductivity tests of unremolded samples can only be conducted on samples that have sufficient cohesiveness to remain intact during sampling, storage, and transport. This limitation biases laboratory tests of permeability on unremolded samples for variable strata like those observed at this site toward materials that are generally more cohesive, more plastic, and have lower hydraulic conductivities. Silty seams generally cannot be tested for laboratory permeability on an unremolded sample because samples containing these materials will fall apart.

I saw evidence of this lack of cohesiveness in many of the samples from the Applicant's and Protestants' 2016 subsurface investigations. Based on my observations, numerous samples would not have been sufficiently cohesive to allow for permeability testing on an unremolded sample.

For soils with gravel and cobbles, like those present in the upper strata at the proposed landfill site, these large clasts are generally removed prior to remolding and placing specimens into a permeameter. Remolding soil removes natural structures like root holes, bedding, fissures or fractures, which often contribute significantly to hydraulic conductivity in the natural setting. The dominant movement of groundwater is likely through these factures or along silt seams and partings. Gypsum seams observed throughout the borings is also indicative of preferential zones of groundwater movement. In sum, because the lithology at this

landfill site is complex and consists of materials that are not consistently cohesive, laboratory permeability analysis of either remolded or unremolded samples is not a reliable indicator of the entire range of permeability of the soils at the site. To obtain a more reliable and representative understanding of the permeability of soils at the site, in-situ permeability analysis is necessary for the complex lithology that exists here.

Q: Are there other indications that hydraulic conductivities reported in the permit application are lower than the range of subsurface conditions at the site?

A: Yes, there are several indications that hydraulic conductivities through some of the materials at the proposed landfill site would be higher than those reported in the 130 Environmental Park LLC landfill application. One indication is that generally hydraulic conductivity of silt or silty sand observed in some of the borings is about 10^{-7} to 10^{-1} centimeters per second. Laboratory measurements of samples from Applicant's supplemental borings by the Applicant indicated hydraulic conductivities as high as 2.5×10^{-6} centimeters per second in sample BME-38 at 44 to 46 feet (see Applicant's Exhibit 130EP-7, p. 32).

Q: Are there additional indications of higher hydraulic conductivities than reported in the 130 Environmental Park LLC landfill application based on the 2013 subsurface investigation?

A: Yes. Protestants measured hydraulic conductivity values on laboratory samples as high as 1.19×10^{-6} centimeters per second in sample MP-1A (which is adjacent to Applicant's Boring BME-32 from the 2013 subsurface investigation) at 43 to 44 feet (see Protestant's Exhibit 5-O). These results indicate the hydraulic conductivity of some of the lithologic material at the proposed landfill site are about 100 times higher than the values represented in the 130 Environmental Park LLC permit application based on the 2013 subsurface investigation.

Errors in the Conceptual Groundwater Model

Q: Are there other inconsistencies in the groundwater data reported in the landfill permit application?

A: Yes. The application says that groundwater occurs in the weathered Midway Clay at the interface between Stratum II and Stratum III: ***"groundwater occurs at the site in shallow weathered silty fat clay (Stratum II), just above its interface with the underlying stratum III unweathered Midway, under unconfined, water table conditions."*** (130 Environmental Park LLC – Type I Technically Complete October 23, 2014, Part III, Attachment E page E-19). But to the extent that Applicant's piezometers actually measure groundwater levels at this interface, they indicate that the interface is mostly dry. This discrepancy raises questions regarding the validity of the descriptions of the occurrence of groundwater and the data on which they are based.

Greater Leachate Migration Potential than Represented by Application

Q: Is there evidence that the potential for leachate migration from the proposed 130 Environmental Park LLC landfill would be greater than what is represented in the permit application?

A: Yes, there are several indications of a greater potential for leachate migration than what is presented in the permit application. These indications include the presence of lithology other than the uniform high plasticity clay presented in the application boring logs. These materials, as described above, include sandy silt seams, silty sand seams, clayey sand with gravel, laminated claystone and clayey gravel. Leachate will preferentially migrate through these seams and lenses at a rate much more rapid than through surrounding clay material. Calculation of leachate travel times based on transmission through clay will be significantly lower than travel times through these materials.

Q: What are some of the other indications of a greater and more rapid potential for leachate migration than the analysis in the 130 Environmental Park LLC landfill permit application based on the 2013 subsurface characterization?

A: Other indications of a greater and more rapid potential for leachate migration than the analysis in the 130 Environmental Park LLC landfill permit application based on the 2013 subsurface characterization include identification of fractures and

fissures in the clay material, patterns of differential weathering, and lost circulation during the drilling of Applicant's boring BME-43.

Q: Please describe the lost circulation at boring BME-43 that you mentioned.

A: During the drilling of this boring, both Applicant's and Protestants' experts describe loss of 100 to 200 gallons of drilling fluid into the subsurface. The loss of this amount of drilling fluid over a relatively short period indicates the presence of a discrete fluid migration pathway in the subsurface.

Q: What do these facts and occurrences indicate regarding potential leachate migration?

A: Fractures and fissures in clay are common because of its high shrink-swell. In clay soils, they can be the dominant control on water migration and influence deep infiltration as well as subsurface storage. In these conditions, calculations of groundwater movement based on Darcy's law, and an assumption of uniform porous media, yield misleading results. Differential zones of potential leachate migration are demonstrated by the loss of 200 gallons of drilling fluid in Applicant's boring BME-43 at a depth of approximately 28 to 30 feet. This drilling fluid loss is inconsistent with the geologic descriptions in the permit application based on the 2013 subsurface investigation. While it is included in the applicant's supplemental material, there is no adjustment to the estimated range of hydraulic conductivity at the site based on its occurrence, or adjustment of the potential for leachate migration.

Q: Why is it important to represent the range of subsurface conditions at a proposed landfill site, and not just the dominant conditions, or average conditions?

A: The most basic reason is to accurately represent the complexity of the lithology that exists at the site and to present an accurate subsurface geologic characterization, consistent with professional standards and in compliance with TCEQ's regulatory requirements. Further, it is important to represent the range of subsurface conditions because groundwater and landfill leachate will flow preferentially through more transmissive materials and conditions. These more transmissive materials and conditions include strata with significant amounts of

gravel, sand, and silt, compared to uniformly clay material. They also include silty, sandy, or gravelly seams and lenses, fissures, fractures and faults. There is evidence of all of these conditions at the proposed landfill site, yet none of them is reflected in the Applicant's estimates of the potential leachate migration.

Q: What is the significance of the loss of drilling fluid at Applicant's boring BME-43 that you described?

A: Lost circulation in Applicant's boring BME-43, coupled with notable gypsum crystal horizons that I observed in Protestants' boring MP-3 at a depth of 45 to 50 feet, demonstrate zones of preferential groundwater migration near these two borings. Both the Applicant and Protestants document the frequent occurrence of fractures and fissures in these borings. The difference in the depth of the weathered/unweathered contact in Applicant's boring BME-43 (36 feet below grade) and Protestants' boring MP-3 (50 feet below grade) over a distance of less than 50 feet also indicates complex pathways of groundwater migration at this location. In other words, the loss of circulation indicates that a zone of preferential groundwater transmission and potential leachate migration exists at this location.

Q: What makes the gypsum crystal horizons in Protestants' boring MP-3 notable, in your opinion?

A: I was able to observe samples from most of the Applicant's supplemental borings and Protestants' borings in January, February, and March 2016. While there were frequent gypsum seams and veins in all of the borings, gypsum deposits in samples from boring MP-3 at 45 to 50 feet were significantly larger, more extensive, and clustered into groups in a way that was unusual compared to other samples that I observed.

Q: Is there evidence of complexity in the unweathered/weathered zone contact that is not represented by the 130 Environmental Park LLC landfill permit application?

A: Yes. Applicant's Exhibit 130EP-7, p. 18 is a map of the proposed landfill footprint with the elevation of the weathered/unweathered contact at each of the Applicant's and Protestants' boreholes. At several locations, more than one

borehole was drilled in close proximity. Protestants' Exhibit 5-U: Table of Borings in Close Proximity with Weathered/Unweathered Contact Elevation Differences is a table I created illustrating contact elevation differences reported by the Applicant. At six locations where more than one borehole was drilled, differences in the weathered/ unweathered contact elevations between borings range from 4.43 feet to 17.11 feet. All differences except at one location are more than five feet. This irregularity in the weathered/unweathered contact indicates that smooth 10-foot contour lines on this surface presented in the 130 Environmental Park LLC Landfill permit application on Figure E6-2 and on Applicant's Exhibit 130EP-7, p. 18 fail to represent actual conditions beneath the landfill site. This irregular contact elevation further indicates that groundwater flow at the site is through fractures and fissures, rather than uniformly across a smooth weathered/unweathered surface, as postulated by the applicant in the calculation of groundwater gradients and velocity.

Q: Are there inconsistencies in the mapped direction of groundwater flow in the 130 Environmental Park LLC Landfill permit application?

A: Yes. Figure E6-2 in the application is a map showing the direction of groundwater flow that is presented as a basis for evaluating the groundwater gradient below the proposed landfill site. In addition to the concerns that I expressed above, there are additional inconsistencies in data represented on this map. On inconsistency is in the delineation of contours on the top of Stratum III. The 520 feet mean sea level contour is very close to boring BME-1, even though the identified contact elevation is 528.91, much closer to 530 feet than to 520 feet. Furthermore, the direction of flow arrows on this map, shown in blue, indicate that groundwater flow would be from the center of the landfill toward its edges. Piezometer P-01, however, is one of only three piezometers that have historically recorded the presence of water. A high water elevation of 534.14 feet mean sea level in this piezometer is inconsistent with the absence of water in Piezometer P-07, where the weathered/unweathered contact is represented as being at 524.95 feet. These inconsistencies indicate inaccuracies in the groundwater conceptual model, the weathered/unweathered contact elevations represented on the map, and/or the

ability of the piezometers to reliably indicate the presence of water beneath the proposed landfill site.

Q: Are Applicant's piezometers adequate to determine whether groundwater is present at the weathered/unweathered contact?

A: Based on measurements of the bottom of the Applicant's piezometers that I took on August 27, 2015, most of the piezometers' bottoms appear to be higher than the weathered/ unweathered contact. Protestants' Exhibit 5-W: Map of Piezometer Bottom Elevations is a map that I prepared to compare my calculated piezometer bottom elevations to the Applicant's weathered/unweathered contact elevation. Based on the information in this map, nine piezometer bottoms are more than a foot higher than the contact elevation. The bottoms of six piezometers are more than five feet higher than the contact elevation. Based on this information, these piezometers would not be expected to measure groundwater at the weathered/unweathered contact, even if it were present at that location.

Q: Do you have other concerns regarding measured groundwater elevations and the proposed landfill excavation?

A: Yes. Given the lack of conclusive evidence regarding the elevation of the weathered/unweathered contact and whether the Applicant's piezometers are properly completed to detect the presence of groundwater at this location, I have a concern regarding the proposed depth of excavation and the high groundwater level of 534.14 feet mean sea level in Piezometer P-01. I prepared Protestants' Exhibit 5-AE: Landfill Excavation Cross Sections and Historical High Groundwater Level Measured in Applicant's Piezometers. This exhibit is based on the geologic sections presented in the application in Drawings E3-2 through E3-9. I have added to the application geologic sections a red line at an elevation of approximately 534.14 feet mean sea level, corresponding to the highest water level elevation measured in piezometers at the site. This exhibit demonstrates that significant portions of the landfill would be excavated to depths that are lower than the measured groundwater elevation in this piezometer.

VI. FAILURE TO ADEQUATELY REPRESENT FLOOD RISKS TO PROPOSED LANDFILL

Drainage System and co-linear boundaries

Q: Where is the proposed 130 Environmental Park LLC landfill facility located in Caldwell County with respect to surface hydrology?

A: The proposed 130 Environmental Park LLC is located within the watershed of Dry Creek and an unnamed tributary to Dry Creek. It is proposed to be located upstream of the Plum Creek Floodwater Retarding Structure No. 21.

Q: Please describe the Plum Creek Floodwater Retarding Structure No. 21.

A: Plum Creek Floodwater Retarding Structure No. 21 was constructed in 1962 on Dry Creek, a tributary to Plum Creek, and five miles north of Lockhart, Texas. The dam is a homogeneous earthfill structure, 2,982 feet long and a maximum of 30 feet high. Front and back slopes are 2.5 horizontal to 1 vertical. Floodwater Retarding Structure No. 21 was constructed to provide flood control for storm runoff from the 5,075-acre upstream watershed. The original evaluated project life was 50 years.

The dam was designed to temporarily store runoff from a 25-year frequency rainfall, or 5.45 inches of runoff from the contributing watershed, without flow through the earthen auxiliary spillway. This standard was based on Class A, low-hazard conditions wherein a dam break would affect downstream agricultural land and facilities but not result in potential loss of life.

The Dam Assessment Report, however, reclassified the dam as high hazard due to downstream urban development in the intervening years. The Texas Commission on Environmental Quality Simplified Breach Method predicted a 21-foot catastrophic flood breach wave with a maximum discharge of 54,660 cubic feet per second. Such a breach would place at risk 26 downstream houses, three Farm-to-Market roads and three county roads used by more than 6,000 vehicles daily.

Based on Floodwater Retarding Structure No. 21's reclassification as a high-hazard dam, the appropriate design standard would be temporary storage of the 100-year, 10-day storm without flow through the earthen auxiliary spillway, with

a drawdown of at least 85% of the temporary storage within 10 days, and capacity to the pass runoff from the Probable Maximum Precipitation (PMP) storm without overtopping.

The current dam does not meet these high-hazard standards. Therefore the failure potential for this structure due to deficient hydrologic capacity is ***"judged to be high."*** Furthermore, a dam inspection by M&E Consultants (for Natural Resources Conservation Service) and a representative of the Plum Creek Conservation District on November 3, 2009 found that grass cover on the dam and auxiliary spillway was poor due to drought and grazing. Poor vegetation cover due to drought and grazing increases the risk of soil erosion and further contributes to the failure potential of this dam, beyond its deficient hydrologic capacity.

Q: Do you have information about what it would take to rehabilitate the Floodwater Retarding Structure No. 21?

A: Yes. Based on information presented in a public hearing that I attended on February 3, 2016 hosted by the Plum Creek Conservation District, rehabilitation of Floodwater Retarding Structure No. 21 would consist of the following elements:

a. Removing the existing principal spillway inlet and constructing a new principal spillway inlet tower and 42-inch discharge conduit. The principal spillway crest would be lowered approximately 5.94 feet to an elevation 500.0.

b. The dam would be lengthened by 400 feet to the east to close off the existing auxiliary spillway. A new, 300-foot wide reinforced concrete auxiliary spillway with a crest elevation of 517.4 feet would be constructed.

c. The top of the dam would be raised approximately 4.0 feet to elevation 526.5 feet.

d. New rock riprap wave protection would be provided (presumably on the upstream dam face).

e. Upstream and downstream embankment slopes would be flattened to slopes of 3 horizontal to 1 vertical.

The proposed improvements would provide a safer dam by beginning water evacuation behind the dam more quickly; and by providing a dam and spillway structure more resistant to failure through seepage, over-topping, and/or slope instability. The proposed flatter slopes would reduce the slope instability potential and allow increased rainfall infiltration and more robust vegetation during drought conditions.

The proposed dam improvements are projected to cost $6,285,600. The Natural Resources Conservation Service (NRCS) share of the total cost would be $4,360,400. Local sponsors would be required to contribute $1,925,200. Whether federal agencies would participate in the project's cost share beyond its original project life is questionable, as is the availability of funds from local sponsors.

Q: Do you have concerns regarding whether proposed improvements for Floodwater Retarding Structure No. 21 are consistent with findings in the Dam Assessment Report?

A: Yes. Information presented in the public hearing on February 3, 2016 failed to address whether proposed improvements for Floodwater Retarding Structure No. 21 would achieve the design standards required for high-hazard dams. Specifically, there is no information documenting storage of the 100-year, 10-day storm without flow through the auxiliary spillway, drawdown of at least 85% of the temporary storage capacity within 10 days, or capacity to pass runoff from the Probable Maximum Precipitation storm without overtopping, as recommended in the dam assessment report.

The preliminary Floodwater Retarding Structure No. 21 improvements design fails to account for construction of the proposed 202-acre 130 Environmental Park LLC Landfill and supporting facilities within this structure's contributing watershed. The Floodwater Retarding Structure No. 21 improvement design assumes that future development in the contributing watershed, including the proposed 130 Environmental Park LLC landfill will fully mitigate storm runoff

impacts. This assumption, however, fails to address downstream flood protection for several reasons.

Q: Please explain why, in your opinion, this assumption fails to address downstream flood protection.

A: Existing soils at the proposed landfill site are primarily Wilson gravelly loam, with 1 to 5 percent slopes. The Natural Resource Conservation Service Web Soil Survey describes their saturated hydraulic conductivity rating as 8×10^{-5} centimeters per second. The available water capacity for these soils is 0.13 centimeters per centimeter, and the available water storage is 19 centimeters in the soil profile from 0 to 150 centimeters. By contrast, the proposed final cover system for the landfill will include a flexible membrane cover. This flexible membrane layer, consisting of 40-mil thick linear low-density polyethylene, would limit infiltration into the proposed landfill subsurface, compared to existing conditions, and limit the available water capacity of the final landfill cover. Both of these factors would increase storm runoff volume from the site compared to current conditions.

The proposed landfill design includes a perimeter drainage system designed to convey runoff from the 25-year and 100-year rainfall events. Detention ponds are proposed to provide storage to mitigate landfill impacts on downstream receiving channels. The landfill design, however, fails to account for the following factors:

- Final cover drainage swales and chutes are designed to convey the 25-year, 24-hour peak flow rates. These peak flow rates, however, fail to account for decreases in times of concentration over the landfill surface that will change the timing of runoff in Floodwater Retarding structure No. 21 reservoir.
- Protestants' Exhibit 5-Y shows that detention ponds and drainage structures are proposed to be located either close or immediately adjacent to the FEMA-mapped 100-year floodplain. Given the limitations of both floodplain mapping, and of the 100-year flood design standard, there is a significant probability of flood encroachment of the proposed drainage

facilities over the 44-year projected facility life and the 30-year post-closure period. The probability of a flood equal to or greater than the 100-year flood during the projected 44-year landfill operational life is 36 percent. The probability of a flood equal to or greater than the 100-year flood during the projected landfill operational life plus 30-year post-closure period is 52 percent. In other words, there is a better than 50-50 chance of a flood greater than the 100-year flood, with more extensive inundation and erosion during the landfill operational life and post-closure period. A landfill storm runoff retention berm failure during flood conditions would further exacerbate flooding downstream.

- Hydraulic modeling for the proposed landfill was accomplished based on a downstream boundary condition resulting from a maximum water surface elevation in Reservoir No. 21 of 518.9 feet. There is no analysis, however, of the effect of raising the dam top from 4.0 feet to 526.5 feet, or constructing a new auxiliary spillway with a crest elevation of 517.4 feet on the hydraulic modeling. These changes may result in higher upstream elevations and increased risk of landfill drainage structure erosion and/or inundation.
- Protestants' Exhibit 5-Z: Comparison of Detention Pond Berm Elevations and 100-Year Water Elevations compares applicant's calculated maximum water surface elevation and perimeter berm elevation to the 100-year water elevation in adjacent streams. Elevation differences of more than 13 feet are predicted where segments of the floodplain and pond berm boundaries are virtually collinear (see Ponds 1 and 2, for example). Differences of this magnitude indicated that it may not be possible to construct berms for the proposed detention ponds without incursions into the 100-year flood plain. These incursions will reduce flood storage behind Floodwater Retarding Structure No. 21.

Q: Do you have concerns regarding the reliability of the proposed landfill detention ponds?

A: Yes. Flood storage capacity within the proposed landfill detention ponds must be maintained to achieve no increase in peak runoff from the proposed landfill. There are factors, however, that limit indefinite maintenance of the proposed flood storage capacity. Stormwater management basins, including flood detention basins require regular maintenance to function as designed. This maintenance includes repairing eroded berms, removing sediment, maintaining outfall clearance, and controlling vegetation to maintain berms. After the landfill is closed, however, the landfill operator would only be obliged to maintain the proposed landfill site and structures for 30 years. Furthermore, the post-closure care period may be shortened by the TCEQ if 130 Environmental Park LLC, submits the required certification with supporting documents, signed by an independent registered professional engineer. Without maintenance, the detention basins are unreliable for continuing to function as designed.

Further, existing water availability for the proposed landfill operations is limited. To the extent that proposed detention storage would be used to store water and supplement the available water supply, the flood mitigation capacity of the proposed ponds would be impaired.

Q: Do you have any concerns regarding the potential impacts from erosion and sedimentation?

A: Yes. Vegetation clearing and regrading associated with construction and operation of the proposed landfill and associated drainage system and detention ponds will result in erosion. The landfill application is vague and noncommittal regarding which specific construction-phase erosion and sedimentation controls would be implemented. Furthermore, the application's erosion calculations fail to account for portions of the landfill cover that will be occupied by drainage berms that are steeper than the assumed four horizontal to one vertical slopes in the erosion calculations. Proposed Floodwater Retarding Structure No. 21 improvements fail to account for increases in flood flows associated with sedimentation into either the proposed landfill drainage system or into Floodwater Retarding Structure No. 21 flood pool.

Q: Do you have an opinion about the potential consequences if the proposed improvements to the Floodwater Retarding Structure No. 21 are not completed?

A: Yes. The proposed landfill storm runoff management system is not designed to control runoff for the Probable Maximum Precipitation event, which is the design storm event for a high-hazard dam. Adequate design of Floodwater Retarding Structure No. 21 improvements to meet this standard must consider, therefore, the hydrologic impacts of the proposed landfill during these design conditions.

If the proposed improvements to Floodwater Retarding Structure No. 21 are not funded and completed, the proposed landfill will increase the risk of downstream flooding because:

- The current Floodwater Retarding Structure No. 21 design has not been shown to mitigate increased runoff during the Probable Maximum Precipitation event;
- Construction of the proposed landfill runoff management and drainage facilities will likely encroach into the existing 100-year flood plain;
- There is an increased risk of storm runoff drainage system failure compared to flood mitigation provided by the existing natural landscape;
- Landfill construction is likely to result in increased sediment in the Floodwater Retarding Structure No. 21 reservoir; and
- The maintenance period for the landfill stormwater management system is limited to 30 years and, with TCEQ approval, could be even shorter.

Evidence of More Extensive 100-Year Floodplain than Presented in Application

Q: What is the evidence for a more extensive or different 100-year floodplain than the one presented in the application?

A: The extent of flooding associated with a 100-year rainfall event is determined by implementing two models, in sequence. The first model, based on watershed size, shape, slopes, soils, vegetation, extent of development, and assumed antecedent moisture conditions, predicts the rate of runoff from a specified sequence of rain associated with a risk-probability. The second model calculates flood elevations

based on runoff rates from the first model and a numerical representation of the shapes, slopes, and roughness of flow pathways. Results from both models are based on simplified representations of complex systems. They are regularly changed and updated.

Q: Have there been changes in the predicted extent of the 100-year floodplain at or near the proposed 130 Environmental Park LLC landfill?

A: Yes. Protestants' Exhibit 5-Y: Proposed Drainage Structure Plan and 100-year Floodplain shows two different delineations of the 100-year floodplain based on two different sources. I prepared this map by registering a map of the proposed landfill drainage system in GIS with 100-year floodplain information. The gray-shaded area on this exhibit is the extent of the 100-year floodplain based on GIS information that I obtained from the Capitol Area Council of Governments on March 30, 2010. The blue area is the Federal Emergency Management Agency (FEMA) 100-year floodplain for this location based on information on their website on January 28, 2016. The earlier floodplain map (the area in gray) indicates that two of the proposed landfill detention ponds and some of the road and other drainage facilities would encroach into the 100-year floodplain. Based on the current FEMA 100-year floodplain, some lengths of the proposed landfill berms are virtually collinear with the 100-year floodplain and part of the Pond 2 berm encroaches into the floodplain.

Q: Are you surprised by the differences between the two mapped areas of 100-year floodplain inundation?

A: No. I have reviewed numerous 100-year floodplain maps since I was involved in developing similar maps for the FEMA program in 1978 in Harris County, Texas. Both maps are within normal ranges of uncertainty associated with 100-year floodplain delineations.

Changes to Base Elevation

Q: Is there other evidence of uncertainty associated with the 100-year floodplain map as currently delineated by FEMA?

A: Yes. There are other indications of potential errors in FEMA's current delineation of the 100-year floodplain. One such indication is a recent adjustment of base flood elevations for nearby Caldwell and Hays County waterways. In 2015 the Federal Emergency Management Agency (FEMA) released advisory maps which expanded floodplains along the banks of the Blanco and San Marcos Rivers in southern Hays County based on flooding associated with rains during the Memorial Day 2015 weekend. Protestants' Exhibit 5-AA compares the 100-year floodplain mapped by FEMA on the effective Flood Insurance Rate Map (left panel) to an Advisory Base Flood Elevation Map (right panel) at a location 16.5 miles southwest of the proposed landfill on the San Marcos River. Comparing the two maps on this exhibit demonstrates significant additional areas of flooding. Two panels in the lower left corner of each map compare the Effective Base Flood Elevation and the Advisory Base Flood Elevation at the pin location. The anticipated increase in flood elevation at this location is 567.8 to 572.9 feet, or 5.1 feet. Were base flood elevations and the extent of flooding to increase at the proposed landfill site in the same way as for areas of nearby Caldwell and Hays County, floodplain encroachment and the risk of flooding at the proposed landfill site would be greater than that indicated by the currently-effective 100-year floodplain maps.

Failure to account for the effect of existing wetland features and ponds in hydrologic calculations, as required by FEMA standard policies

Q: Is there a requirement to account for storage in determining existing site runoff?

A: Yes. Existing storm runoff storage on the proposed landfill site affects discharge. The proposed landfill will alter the hydrologic characteristics of its footprint. Based on the landfill application, there are currently eight open-water stock ponds or natural water features on the site. Altogether they occupy more than 20 acres. There are additionally 46 emergent wetlands that have been identified onsite. Both the open-water and wetland features provide existing upstream and supplemental flood storage within the Floodwater Retarding Structure No. 21

contributing watershed. This storage would be eliminated by the proposed regular landfill contours, graded to efficiently drain water from its surface.

Even though wetland features were deemed isolated by the Applicant and not regulated as waters of the United States, they still have a significant hydrologic storage impact on downstream flows. The Federal Emergency Management Agency has established program standards for flood risk analysis and mapping activities in adherence to National Flood Insurance Program requirements. Those standards have been published as a FEMA policy and are included here as Protestants' Exhibit 5-AF: Federal Insurance and Mitigation Administration Policy. Standard SID # 81 on page 16, effective as of November 1, 2009 requires ineffective and non-conveyance areas must be designated to reflect the actual conditions (such as topography and surface roughness) as closely as practical. The site stock ponds, water features and emergent wetland would constitute such ineffective and non-conveyance areas.

Q: Has the applicant considered the existing ponds and wetlands on the site in performing their hydrologic analysis?

A: Not that I can tell.

Portions of the proposed improvements lie within the FEMA-mapped 100-year floodplain

Q: Do you have an opinion regarding portions of the proposed improvements associated with the proposed 130 Environmental Park LLC landfill that would be located within the FEMA-mapped 100-year floodplain?

A: Yes. I prepared Protestants' Exhibit 5-AG: Facility Site Plan and 100-year Floodplain. This exhibit shows the 100-year floodplain as mapped by FEMA with the Facility Site Plan as submitted on Figure IIA.12 in the 130 Environmental Park LLC landfill permit application. The exhibit makes clear that portions of the planned access road and leachate storage tanks would be located within areas delineated a floodplain.

Q: Are there any potential problems with locating these facilities within the 100-year floodplain?

A: Yes. From an operational perspective, it may be difficult to access the landfill during flood conditions. Flooding of the proposed leachate storage facility could compromise its integrity and operational functionality.

VII. CONCLUSION

Q: Does this conclude your testimony?

A: Yes. I do reserve the right to timely supplement or amend my prefiled testimony.

D. Lauren Ross, Ph. D., P. E. – Principal Engineer

Dr. Lauren Ross is an environmental engineer and owner of Glenrose Engineering, Inc. in Austin, Texas since 1987.

Education

Ph. D. Civil Engineering, University of Texas at Austin; 1993.
M. S. Civil Engineering, Colorado State University, Fort Collins, Colorado; 1982.
B. S. Civil Engineering, University of Texas at Austin; 1977, *summa cum laude*

Registration and Certification

Registered Professional Engineer: State of Texas, 1984
OSHA 40-hour Hazardous Waste Health and Safety Training, 1993
Certified Professional in Erosion and Sediment Control, 2009.

Experience

Wastewater Engineering and Permitting

- Design of a constructed wetland system to treat high biochemical oxygen demand and concentrated nutrient wastewater from a tofu production facility.
- Soil, spring, and groundwater monitoring system recommendations for Texas land application systems: Barton Creek West Water Supply Corporation, Rocky Creek Wastewater Utility, Austin Highway 290 (Headwaters), City of Dripping Springs, Travis County Municipal Utility District No. 4, Scenic Greens, Hays County Water Control and Improvement District No. 1, Prentiss Properties Acquisition Limited Partnership
- Water balance modeling for septic systems in the Barton Springs Edwards Aquifer Recharge and Contributing Zones
- Water balance modeling for Three Rivers Refinery wastewater effluent irrigation
- Environmental sampling and/or data analysis associated with wastewater effluent irrigation at Barton Creek West WSC, Hays County Water Control and Improvement District No. 1 (Belterra), Hays County Municipal Utility District No. 5 (Highpointe) Three Rivers Refinery, and West Cypress Hills wastewater effluent irrigation

Ground Water

- Pollution concentration predictions in Barton Springs from a pipeline leak using a numerical model based on field dye trace data
- Evaluation of environmental data to determine coal combustion waste disposal impacts in the Four Corners region
- Groundwater contamination study, waste evaluation, sampling, and analysis for petroleum refinery.
- Closed landfill study: field investigation, compiled and reviewed historical records, assessed potential environmental consequences, installed, sampled, and evaluated data from monitoring wells.
- Conducted geologic assessment, designed and installed groundwater monitoring well system for municipal landfills.

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- Designed a system to limit methane and leached organic chemical migration from a closed municipal landfill into a karst limestone sole-source drinking water aquifer.
- Developed groundwater management alternatives to limit withdrawal and related land subsidence.

Environmental Assessment

- Baseline and impact assessment for wastewater line remediation project including evaluation of soils, geology, topography, and flow regimes.
- Environmental Assessment evaluation for a proposed project to convert an inactive crude oil pipeline, largely constructed in 1950, into active service as a high-pressure fuel transmission line. Work included: evaluating historical spill records; calculating statistical failure probabilities for different pipeline reaches and spill sizes; predicting time and concentrations of toxic and carcinogenic constituent migration through and discharge from a karst limestone aquifer; and evaluating the Operational Reliability Assessment performed for the pipeline.

Solid Waste

- Investigated waste metal migration in soil for petroleum land treatment unit.
- Investigated geologic setting and groundwater contamination and designed recovery well system for groundwater remediation at a commercial RCRA waste storage impoundment.
- Designed petroleum waste land treatment units: baseline soil and groundwater characterization; monitor well system design and installation; lysimeter systems; and land treatment demonstrations to determine maximum waste capacity and loading rates.
- Developed sampling procedures and in-place treatment for RCRA waste at electrical generation power plants.
- Managed and prepared technical phases of Industrial Solid Waste Permit Applications under RCRA and Texas Natural Resource Conservation Commission regulations for waste management facilities: land treatment units, surface impoundments, container storage areas.
- Designed closure plans for RCRA waste impoundments to store, treat and dispose of inorganic acids, spent pickle liquor, and organic chemicals.

Water Quality and Engineering Design

- Gravity-flow retention and irrigation water pollution control system for a large hospital complex within the contributing watershed of the karst Barton Springs Aquifer.
- Design of an innovative bioretention water quality control system for a municipal complex located on the Barton Springs Edwards Aquifer Recharge Zone and permitting under Texas Commission on Environmental Quality Edwards Aquifer protection rules.
- Design of an innovative pervious pavement storm runoff detention and treatment system for a proposed parking lot to be located on the Northern Edwards Aquifer Recharge Zone and permitting under stringent City of Austin and Texas Commission on Environmental Quality water quality protection rules.
- Wet pond design and detention basin retrofit to treat stormwater from existing residential and commercial development in the Oak Springs neighborhood in East Austin.
- Combined wet pond and bioretention design for commercial storm runoff.

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- Combined wet pond and retention/irrigation design for an existing 162-acre residential development over the sensitive Barton Springs recharge zone in the City of Austin, Texas.
- Municipal engineer responsible for all water quality design, review, inspection, rules, and ordinances for the City of Sunset Valley, Texas since 1994.
- Analyzed nonpoint pollution sources and structural and non-structural retrofit controls for recharge and contributing zone of a sensitive karst aquifer.
- Analyzed nonpoint pollution sources and structural and non-structural retrofit controls as water quality engineer for the City of Sunset Valley, Texas.
- Technical consultant to the City of Austin on implementation of the 1991 Comprehensive Watersheds Ordinance and associated water quality monitoring system.
- Analyzed stormwater conveyance and flooding potential, designed regional detention basin to protect natural ecological systems for Armand Bayou Master Drainage Study.
- Estimated long-term groundwater yields based on rainfall rates, soil type, and river losses for Chisumbanje region of Zimbabwe, Africa.
- Evaluated land use, soils, agricultural and silvicultural practices to assess non-point pollution potential in the San Jacinto River Basin.
- Designed storm water drainage for subdivisions and regional water detention facilities.

Teaching

- Semester Course in Statistics for Environmental Monitoring; University of Texas at Austin; Fall 1995.
- Land Development Seminar; Travis County Bar Association, 12 July 1996.
- Water Quality Protection Programs to Reduce Nonpoint Source Pollution, a presentation to the Barton Springs/Edwards Aquifer Conservation District's Watershed Management: Challenges and Innovations--A Nonpoint Source Pollution Conference, 25 July 1996.
- Presenter at Emerging Issues in Groundwater Regulation panel discussion, Key Environmental Issues in U.S. EPA Region VI conference, hosted by U.S. EPA and the American Bar Association, May 12-13, 1997.
- Short Courses in Statistics for Environmental Monitoring; University of Texas Continuing Engineering Studies Program: Spring 1995, Fall 1995, Spring 1996, Spring 1997, Spring 1998.
- Short Courses in Statistics for Environmental Monitoring; Louisiana Department of Environmental Quality. Focus on surface water sampling considerations, trend analysis and methods to assess the achievement of data quality objectives.

Statistics

- Evaluated surface and groundwater measurements for normality, differences in mean, spatial variability, and time series analysis. Techniques used include Student's t-test, Wilcoxon test, parametric and non-parametric ANOVA, Fourier series decomposition, Shapiro-Wilkes test, and Chi-squared tests.
- Geostatistical analysis and kriging of groundwater transmissivity data.
- Statistically-based sampling design including optimum sample number, stratified random sampling, and assessment of monitoring parameters to achieve efficient sampling designs.

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Field/ Laboratory Experience

- Field supervision of auger drilling, rotary-bit drilling, well installation, shelby-tube core and split-spoon sampling, and soil type identification using the Unified Soils Classification System.
- Surface, groundwater and hazardous waste sampling for a variety of constituents, including volatile organic constituents, dioxins, nutrients, metals, anions, cations, and other collection-sensitive parameters.
- Laboratory experiments to measure unsaturated hydraulic conductivity, water content versus soil water pressure, and other geophysical soil properties.

Reports and Publications

- *Barnes Family Farm Water Availability Report*, Barnes Family Farm, Inc., April 2015.
- *Circle Acres Environmental Sampling Report*, Ecology Action, January 2014.
- *Potential Improvements to the Harris County Municipal Separate Storm Sewer MS4 Permit*, Houston Parks Board, Galveston Bay Foundation, Buffalo Bayou Partnership, and Bayou Preservation Association, January 2014.
- *Circle Acres Preliminary Engineering Biofilter Design*, Ecology Action, August 2013.
- *Circle Acres Storm Water Management Concept Plan*, Ecology Action, May 2013.
- *Comments on Draft Environmental Assessment of the Proposed Longhorn Pipeline Reversal*, City of Austin, September 2012.
- *Water for Coal-Fired Power Generation in Texas: Current and Future Demands,* for Sierra Club, February 2012.
- *Land-Applied Wastewater Effluent Impacts on the Edwards Aquifer,* for Greater Edwards Aquifer Alliance and Save Our Springs Alliance, November 2011.
- *Proposed White Stallion Coal-Fired Power Plant Water Demands and the Highland Lakes Water Supply,* for Sierra Club, June 2011.
- *Water Treatment Plant #4 Environmental Monitoring Program,* for City of Austin, with INTERA, Inc., June 2011.
- *Remediation to Protect the Conemaugh River from Acidic Groundwater,* for Environmental Integrity Project, Lisa Widawsky, attorney, March 2011.
- *What Would You Drink if the Well Ran Dry? Nolan County Water and the Proposed Tenaska Coal-Fired Power Plant,* for Lone Star Chapter of the Sierra Club, November 2010.
- *A Unique Water Quality Retrofit Project in Austin, Texas,* with Scott Muchard, Rebecca Batchelder, and Tom Franke, StormCon; The North American Surface water Quality Conference & Exposition, August 5, 2010, San Antonio, Texas.
- *Potential Stormwater Impacts from Sand and Gravel Excavation on the Llano River, Texas,* for Brad Rockwell, attorney, February 2010
- *Engineering Analysis of Jeremiah Ventures L.P. Propose Wastewater Irrigation Areas,* submitted to City of Austin, December 2009.

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- *Pease Park Water Quality and Stream Restoration: Preliminary Engineering Report*, with PBS&J, Inc., for City of Austin, August 2009.
- *Fort Branch Watershed Management Area Reaches 6 and 7; Final Environmental Assessment,* for City of Austin, August 2009.
- *Tannehill Branch Wastewater Line Environmental Assessment,* for City of Austin, August 2009.
- *Water Quality and Quantity Impacts from Proposed South Texas Plant Expansion,* submitted to Sustainable Energy and Economic Development (SEED) Coalition, April 2009.
- *City of Sunset Valley Environmental Monitoring Program: Air Quality,* submitted to the City of Sunset Valley, Texas, November 2008.
- *Recommendations to Stabilize Construction at Ranches at Hamilton Pool,* submitted to Brad Rockwell, attorney, October 2008.
- *Williamson Tributary 2 Water Quality Retrofit: Preliminary Design,* prepared for the City of Austin, October 2008.
- *Twin Oaks Community: Conceptual Design for Tofu Wastewater Treatment,* submitted to Twin Oaks Intentional Community, June 2008.
- *City of Sunset Valley Surface Water Quality Monitoring Program,* for the City of Sunset Valley, Texas, June 2008.
- *Storm Sewer Retrofit Alternatives to Improve Water Quality in Fort Branch Creek Reaches 6 and 7,* for City of Austin, December 2007.
- *Lundelius-McDaniel Water Quality Retrofit Project: Phase I Environmental Assessment* for HDR Engineering, Inc., September 2007.
- *Effects of Four Corners Power Plant Coal Combustion Waste Disposal on Surface and Groundwater Quality,* submitted to Lisa Evans, Earth Justice Attorney, August 2007.
- *Preliminary Review of the McCarty Road Landfill Proposed Major Permit Amendment,* submitted to Monica Jacobs, Attorney, August 2007.
- *Surface Water and Sediment Sample Results Associated with the Walsh Cresson Ranch and Walsh West Ranch,* submitted to Mary Sahs, attorney, May 2007.
- *Biofiltration Water Quality Control Design Standards,* submitted to the City of Sunset Valley, Texas, 2007.
- *Review of Proposed XTO Energy, Inc. Centralized Landfarm Facility, Jack County, Texas,* submitted to Robert Thompson, Ph.D., July 2006.
- *Carson Creek Watershed Flood Mitigation Project: Impacts on Erosion and Water Quality,* submitted to PBS&J, Inc., December 2005.
- *Water, Mud, Mold, and More: Toxic Chemicals and Staying Safe When Returning to Coastal Louisiana*, Common Ground Relief, December 2005.
- *West Lamar Wastewater Replacement Line: Phase I Environmental Assessment,* prepared for City of Austin, December 2005.

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- *Lundelius-McDaniels Water Quality Retrofit Project Preliminary Engineering Report,* submitted to City of Austin with HDR Engineering, Inc., October 2005.
- *Surface Water and Sediment Sample Results Associated with the Diamond Shamrock Three Rivers Refinery Wastewater Irrigation Fields,* submitted to: Ms. Mary Sahs, attorney, September 2005.
- *Diamond Shamrock Three Rivers Refinery Wastewater Irrigation Water Balance* submitted to: Ms. Mary Sahs, attorney, June 2005.
- *Intrawell Comparisons for Arsenic and Benzene Concentration Measurements in Maxwell Landfill Monitoring Well 4.* Submitted to: Robert S. Kier Consulting, Inc., June 2005.
- *Groundwater Sampling Protocols: Ruby Ranch Subdivision.* Submitted to Neighbors Organized in Defense of the Environment. May 2005.
- *Oak Springs Detention Pond Retrofit for Water Quality,* for the City of Austin, February 2005.
- *TR-20 Computer Simulations to Determine Runoff Detention Stage/Storage/Discharge Relationships Meeting Specified Erosion Control Criteria* for City of Austin, January 2005.
- *Potential for Surface and Groundwater Contamination at the Waste Management of Texas, Inc. Westside Landfill,* submitted to Mary K. Sahs, attorney, September 2004.
- *Recommendations for Edwards Aquifer Authority Water Quality Regulations.* Presented to the Edwards Aquifer Authority Water Quality Task Force in San Antonio, Texas, 17 February 2004.
- *Tanglewood Forest Regional Detention Pond: Phase I Environmental Assessment,* prepared for City of Austin, October 2003.
- *Effects of Impervious Cover Limits to Improve Water Quality*, submitted to City of Sunset Valley, January 2003.
- *Ecocreto™ Pervious Pavement Water Quality & Flood Control Design.* January 2003.
- *Sampling at the Alcoa Sandow Lignite Mine.* For Neighbors for Neighbors, Inc. December 2002.
- *Preliminary Review of Northern Hays and Southwestern Travis Counties Water Supply System Project Environmental Impact Study; October 2001,* 15 January 2002.
- *Water Quality Design Calculations Wells Branch Church of Christ Austin, Texas* for EcoCreto, Inc. September 2001.
- *Product Pipeline Hazards over Karst Aquifers.* American Society of Civil Engineering Environmental and Pipeline Engineering Convergence 2000. July 23 – 26, 2000, Kansas City, Missouri.
- *Review of the Environmental Assessment of the Proposed Longhorn Pipeline System.* January 2000.
- *Comments on the Final Environmental Assessment of the proposed Longhorn Pipeline System.* January 2001.
- *Water Fights: Citizens Struggle to Shape a City in Central Texas.* 1999. From *Under the Blade: The Conversion of Agricultural Landscapes,* Westview Press, Boulder, Colorado.

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- *Hydrogeologic Setting and Potential Contamination of Barton Springs from a Longhorn Pipeline Discharge.* September 1998.
- *Watershed Protection Utility Master Plan: Integrated Solutions Regulatory Inventory.* Prepared for the City of Austin. August 1998.
- *Watershed Protection Utility Master Plan: Integrated Solutions Regulatory Protocols.* Prepared for the City of Austin. July 1998.
- *Statistical Analysis of Soil Samples for Quanex Land Treatment Unit.* December 1997. Prepared Quanex Gulf States Tube Division.
- *A Scientific Basis for Edwards Aquifer Protection,* prepared for the American Bar Association Conference: Key Environmental Issues in U.S.EPA Region VI, May 1997. P
- *Robert Mueller Municipal Airport Phase II Environmental Assessment Work Plan.* April 1997. With Geomatrix, Inc., prepared for the City of Austin.
- *Water Quality Protection Programs to Reduce NPS Pollution.* July 1996. Presented at Barton Springs/Edwards Aquifer Conservation District Conference: Watershed Management: Challenges and Innovations.
- *Water Quality Ordinance Amendments to the City of Sunset Valley Land Development Code.* April 1996. Prepared for the City of Sunset Valley.
- *Soil and Water Quality Monitoring Plan for the City of Austin Municipal Golf Courses.* January 1996. Prepared for the City of Austin.
- *D. C. Reed Estate Water Quality Protection Zone Monitoring Program.* January 1996.
- *Soil Monitoring Plan for Utility Trench Segment through SWMU 216.* January 1996. Prepared for the City of Austin.
- *Waller Creek Flood Control Master Plan.* December 1995. Prepared with Loomis and Associates for the City of Austin.
- Barton Springs Water Protection Efforts Challenged. August/September 1995. *Nonpoint Source News-Notes,* published by U. S. EPA.
- *Statistical Methods for Environmental Monitoring*. 5 to 7 April 1995. Lecture notes for Continuing Engineering Studies Short Course, University of Texas at Austin.
- *"Don't Mess with Texas" Litter Survey.* April 1995. Prepared for GSD&M Associates, Inc. With Capitol Environmental Services.
- *Long Term Viability of the Edwards Aquifer for the City of Sunset Valley Water Supply.* February, 1995. Report prepared for the City of Sunset Valley.
- *Character and Magnitude of Degradation in* the *Barton Springs Zone.* December 1994. Report prepared for Loomis and Associates as part of the Barton Springs Zone Retrofit Project, Austin, Texas.
- *Report on Septic Systems in* the *Barton Springs Zone.* December 1994. Report prepared for Loomis and Associates as part of the Barton Springs Zone Retrofit Project, Austin, Texas.
- *"Don't Mess with Texas" Litter Survey Work Plan.* October 1994. Report prepared for GSD&M Associates, Inc. With Capitol Environmental Services.

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- *Statistical Analyses to Establish Constituent Action Limits for Detection Monitoring: Industrial Waste Control Site, Sebastian County, Arkansas.* June 1994. Prepared for IT Corporation.
- *Review of Environmental Information Document for Proposed Lacey Pig Operation.* April 1994. Letter report prepared for Mr. Michael J. Hobbs.
- *Barton Creek and Barton Springs: Petition to Texas Natural Resource Conservation Commission for Designation as Outstanding National Resource Waters.* April 1994. (with others).
- *Base Flow in Barton Creek and Statistical Analysis of Water Quality Data for Barton Creek and Barton Springs, Austin, Texas.* March 1994. Report prepared for Loomis, Santos and Associates.
- *Statistical Analysis: Background Sampling Investigation at Bergstrom Air Force Base, Texas.* January 1994. Prepared for Southwest Laboratories.
- *Multivariate Statistical Analysis of Environmental Monitoring Data.* November 1993. Petroleum Hydrocarbons Conference sponsored by the National Ground Water Association and American Petroleum Institute, Houston, Texas.
- *An Environmentalist's Perspective on Pump-and-Treat Groundwater.* 1993. In *Ground Water Monitoring and Remediation*, Vol. XIII, No. 4.
- *The Importance of the SOS Water Quality Ordinance to the Protection of the Barton Springs Segment of the Edwards Aquifer.* September 1993. Prepared for the Texas Natural Resource Conservation Commission.
- *Statistical Analyses to Establish Constituent Action Limits for Detection Monitoring.* June 1993. Report prepared for IT Corporation for IWC Site in Fort Smith, Arkansas.
- *Multivariate Statistics for Environmental Monitoring Data.* May 1993. Doctoral Dissertation for the University of Texas at Austin.
- *Statistical Analyses to Establish Constituent Action Limits for Detection Monitoring.* May 1993. Prepared for IT Corporation.
- *Statistical Analysis of Phase I and Phase II Background Soil Measurements.* February 1993. Report prepared for Quanex Corporation.
- *Sampling Recommendations to Detect Chromium Contamination in Soils.* 16 August 1993. Letter report to Mr. Phil Bullock, Southwest Laboratories.
- *Recommendations for Sampling: West Dallas Lead Project.* August 1992. Prepared for International Technology Corporation.
- *Implementation Strategy for the Pollution Reduction Standard of the SOS Water Quality Referendum.* July 1992. Prepared for Save Our Springs Coalition (SOS).
- *Statistical Determination of Background Values for Groundwater Based on Student's T-Test, Tolerance Interval and Mann-Whitney Analysis.* September 1991. Prepared for Quanex Corporation.
- *Phase I Environmental Site Assessment: Jollyville/360 Tract; 9401 Capitol of Texas Highway; Austin, Texas.* June 1991. (with others).

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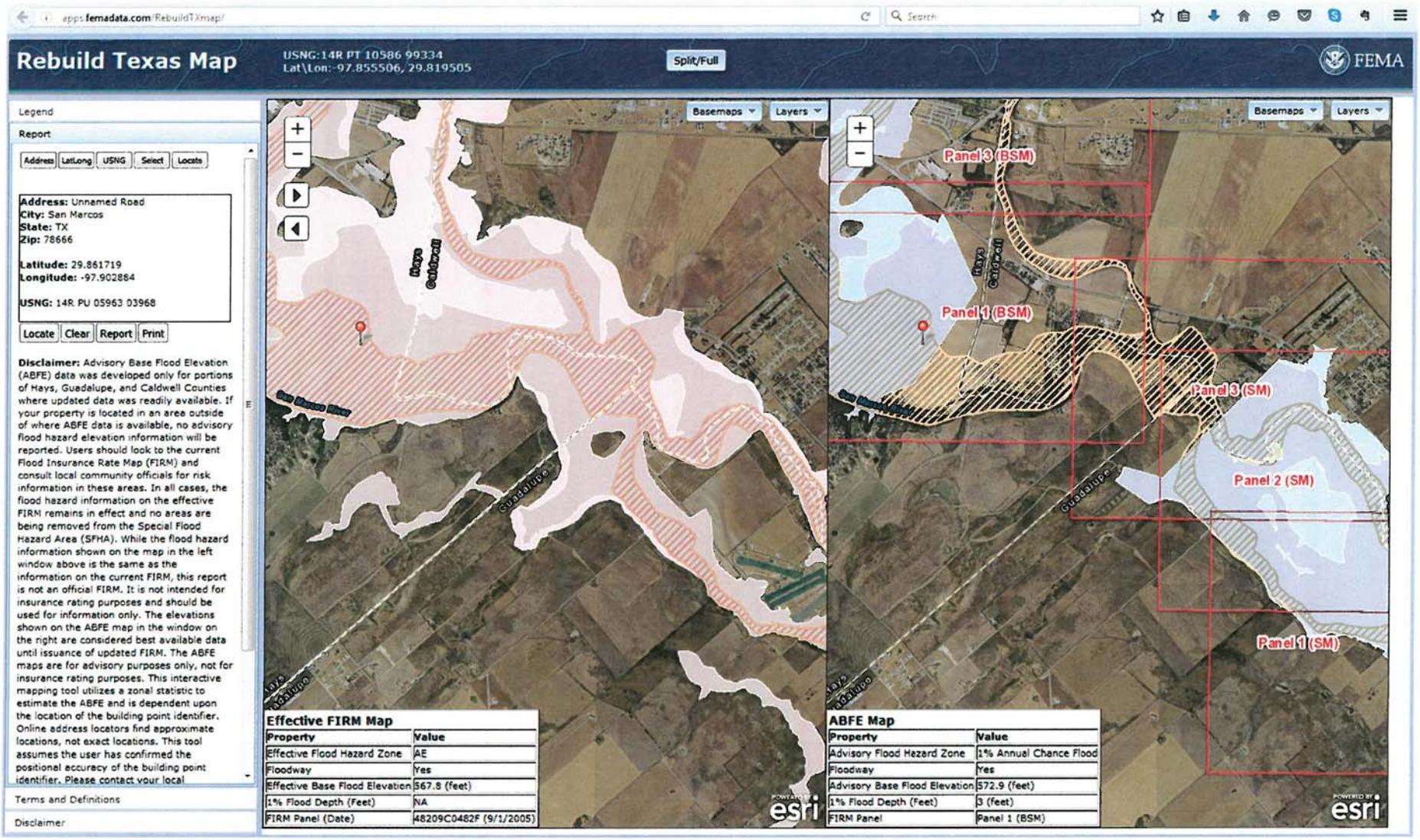
Protestants' Exhibit 5-AA:

Comparison of Effective Flood Insurance Rate Map and Adjusted Base Flood Elevation Map for Location near Hays and Caldwell County Lines

STATE OF TEXAS
D. LAUREN ROSS
56647
LICENSED
PROFESSIONAL ENGINEER

June 26, 2016



Protestants' Exhibit 5-AB:

Applicant's Photograph of Surface Gravel

Photograph provided by Applicant in Production.

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Measurement in Medicine: the Analysis of Method Comparison Studies†

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Summary: Methods of analysis used in the comparison of two methods of measurement are reviewed. The use of correlation, regression and the difference between means is criticized. A simple parametric approach is proposed based on analysis of variance and simple graphical methods.

1 The problem

In medicine we often want to compare two different methods of measuring some quantity, such as blood pressure, gestational age, or cardiac stroke volume. Sometimes we compare an approximate or simple method with a very precise one. This is a calibration problem, and we shall not discuss it further here. Frequently, however, we cannot regard either method as giving the true value of the quantity being measured. In this case we want to know whether the methods give answers which are, in some sense, comparable. For example, we may wish to see whether a new, cheap and quick method produces answers that agree with those from an established method sufficiently well for clinical purposes. Many such studies, using a variety of statistical techniques, have been reported. Yet few really answer the question "Do the two methods of measurement agree sufficiently closely?"

In this paper we shall describe what is usually done, show why this is inappropriate, suggest a better approach, and ask why such studies are done so badly. We will restrict our consideration to the comparison of two methods of measuring a continuous variable, although similar problems can arise with categorical variables.

2 Incorrect methods of analysis

We shall first describe some examples of method comparison studies, where the statistical methods used were not appropriate to answer the question.

Comparison of means
Cater *(1979)* compared two methods of estimating the gestational age of human babies.

†Paper presented at the Institute of Statisticians conference, July 1981.

Gestational age was calculated from the last menstrual period *(LMP)* and also by the total maturity score based on external physical characteristics *(TMS)*. He divided the babies into three groups: normal birthweight babies, low birthweight pre-term (< 36 weeks gestation) babies, and low birthweight term babies. For each group he compared the mean by each method (using an unspecified test of significance), finding the mean gestational age to be significantly different for pre-term babies but not for the other groups. It was concluded that "the TMS is a convenient and accurate method of assessing gestational age in term babies".

His criterion of agreement was that the two methods gave the same mean measurement; "the same" appears to stand for "not significantly different". Clearly, this approach tells us very little about the accuracy of the methods. By his criterion, the greater the measurement error, and hence the less chance of a significant difference, the better.

Correlation

The favourite approach is to calculate the product-moment correlation coefficient, r, between the two methods of measurement. Is this a valid measure of agreement? The correlation coefficient in this case depends on both the variation between individuals (i.e. between the true values) and the variation within individuals (measurement error). In some applications the "true value" will be the subject's average value over time, and short-term within-subject variation will be part of the measurement error. In others, where we wish to identify changes within subjects, the true value is not assumed constant.

The correlation coefficient will therefore partly depend on the choice of subjects. For if the variation between individuals is high compared to the measurement error the correlation will be high, whereas if the variation between individuals is low the correlation will be low. This can be seen if we regard each measurement as the sum of the true value of the measured quantity and the error due to measurement. We have:

variance of true values = σ_T^2
variance of measurement error, method A = σ_A^2
variance of measurement error, method B = σ_B^2

In the simplest model errors have expectation zero and are independent of one another and of the true value, so that

variance of method A = $\sigma_A^2 + \sigma_T^2$
variance of method B = $\sigma_B^2 + \sigma_T^2$
covariance = σ_T^2 (see appendix)

Hence the expected value of the sample correlation coefficient r is

$$\rho = \frac{\sigma_T^2}{\sqrt{(\sigma_A^2 + \sigma_T^2)(\sigma_B^2 + \sigma_T^2)}}$$

Clearly ρ is less than one, and it depends only on the relative sizes of σ_T^2, σ_A^2 and σ_B^2. If σ_A^2 and σ_B^2 are not small compared to σ_T^2, the correlation will be small no matter how good the agreement between the two methods.

In the extreme case, when we have several pairs of measurements on the same individual, $\sigma_T^2 = 0$ (assuming that there are no temporal changes), and so $\rho = 0$ no matter how close the agreement is. Keim *et al.* (1976) compared dye-dilution and impedance cardiography by finding the correlation between repeated pairs of measurements by the two methods on each of 20 patients. The 20 correlation coefficients ranged from –0.77 to 0.80, with one correlation being significant at the 5 per cent level. They concluded that the two methods did not agree because low correlations were found when the range of cardiac output was small, even though other studies covering a wide range of cardiac output had shown high correlations. In fact the result of their analysis may be

explained on the statistical grounds discussed above, the expected value of the correlation coefficient being zero. Their conclusion that the methods did not agree was thus wrong - their approach tells us nothing about dye-dilution and impedance cardiography.

As already noted, another implication of the expected value of r is that the observed correlation will increase if the between subject variability increases. A good example of this is given by the measurement of blood pressure. Diastolic blood pressure varies less between individuals than does systolic pressure, so that we would expect to observe a worse correlation for diastolic pressures when methods are compared in this way. In two papers (Laughlin *et al.*, 1980; Hunyor *et al.*, 1978) presenting between them 11 pairs of correlations, this phenomenon was observed every time (Table 1). It is not an indication that the methods agree less well for diastolic than for systolic measurements. This table provides another illustration of the effect on the correlation coefficient of variation between individuals. The sample of patients in the study of Hunyor *et al.* had much greater standard deviations than the sample of Laughlin *et al.* and the correlations were correspondingly greater.

Table 1. Correlation coefficients between methods of measurement of blood pressure for systolic and diastolic pressures

	Systolic pressure			Diastolic pressure		
	s_A	s_B	r	s_A	s_B	r
Laughlin et al. (1980)						
1	13.4[a]	15·3[a]	0.69	6.1[a]	6.3[a]	0.63
2			0.83			0.55
3			0.68			0.48
4			0.66			0.37
Hunyor et al. (1978)						
1	40.0	40.3	0.997	15·9	13.2	0·938
2	41.5	36.7	0.994	15.5	14.0	0.863
3	40.1	41.8	0.970	16.2	17.8	0.927
4	41.6	38.8	0.984	14.7	15.0	0.736
5	40.6	37.9	0.985	15·9	19·0	0.685
6	43.3	37.0	0.987	16.7	15.5	0.789
7	45.5	38.7	0.967	23.9	26.9	0.941

[a] Standard deviations for four sets of data combined.

A further point of interest is that even what appears (visually) to be fairly poor agreement can produce fairly high values of the correlation coefficient. For example, Serfontein and Jaroszewicz (1978) found a correlation of 0.85 when they compared two more methods of assessing gestational age, the Robinson and the Dubowitz. They concluded that because the correlation was high and significantly different from zero, agreement was good. However, from their data a baby with a gestational age of 35 weeks by the Robinson method could have been anything between 34 and 39.5 weeks by the Dubowitz method. For two methods which purport to measure the same thing the agreement between them is not close, because what may be a high correlation in other contexts is not high when comparing things that should be highly related anyway. The test of significance of the null hypothesis $\rho = 0$ is beside the point. It is unlikely that we would consider totally unrelated quantities as candidates for a method comparison study.

The correlation coefficient is not a measure of agreement; it is a measure of association.

Thus it is quite wrong, for example, to infer from a high correlation that "the methods . . . may be used interchangeably" (Hallman and Teramo, 1981).

At the extreme, when measurement error is very small and correlations correspondingly high, it becomes difficult to interpret differences. Oldham *et al.* (1979) state that: "Connecting [two types of peak flow meter] in series produces a correlation coefficient of 0.996, which is a material improvement on the figure of 0.992 obtained when they are used separately". It is difficult to imagine another context in which it were thought possible to improve materially on a correlation of 0.992. As Westgard and Hunt (1973) have said: "The correlation coefficient ... is of no practical use in the statistical analysis of comparison data".

Regression

Linear regression is another misused technique in method comparison studies. Often the slope of the least squares regression line is tested against zero. This is equivalent to testing the correlation coefficient against zero, and the above remarks apply. A more subtle problem is illustrated by the work of Carr *et al.* (1979), who compared two methods of measuring the heart's left ventricular ejection fraction. These authors gave not only correlation coefficients but the regression line of one method, Teichholz, on the other, angiography.

They noted that the slope of the regression line differed significantly from the line of identity. Their implied argument was that if the methods were equivalent the slope of the regression line would be 1. However, this ignores the fact that both dependent and independent variables are measured with error. In our previous notation the expected slope is $\beta = \sigma_T^2/(\sigma_A^2 + \sigma_T^2)$ and is therefore less than 1. How much less than 1 depends on the amount of measurement error of the method chosen as independent. Similarly, the expected value of the intercept will be greater than zero (by an amount that is the product of the mean of the true values and the bias in the slope) so that the conclusion of Ross *et al.* (1982) that "with a slope not differing significantly from unity but a statistically highly significant *y*-intercept, the presence of a systematic difference ... is demonstrated" is unjustified.

We do not reject regression totally as a suitable method of analysis, and will discuss it further below.

Asking the right question

None of the previously discussed approaches tells us whether the methods can be considered equivalent. We think that this is because the authors have not thought about what question they are trying to answer. The questions to be asked in method comparison studies fall into two categories:

(a) Properties of each method:
    How repeatable are the measurements?

(b) Comparison of methods:
    Do the methods measure the same thing on average? That is, is there any relative bias? What additional variability is there? This may include both errors due to repeatability and errors due to patient/method interactions. We summarize all this as "error".

Under properties of each method we could also include questions about variability between observers, between times, between places, between position of subject, etc. Most studies standardize these, but do not consider their effects, although when they are considered, confusion may result. Altman's (1979) criticism of the design of the study by Serfontein and Jaroszewicz (1978) provoked the response that: "For the actual study it was felt that the fact assessments were made by two different observers (one doing only the Robinson technique and the other only the Dubowitz method) would result in greater objectivity" (Serfontein and Jaroszewicz, 1979). The effects of method and observer are, of course, totally confounded.

We emphasize that this is a question of *estimation,* both of error and bias. What we need is a design and analysis which provide estimates of both error and bias. No single statistic can estimate both.

3 Proposed method of analysis

Just as there are several invalid approaches to this problem, there are also various possible types of analysis which are valid, but none of these is without difficulties. We feel that a relatively simple pragmatic approach is preferable to more complex analyses, especially when the results must be explained to non-statisticians.

It is difficult to produce a method that will be appropriate for all circumstances. What follows is a brief description of the basic strategy that we favour; clearly the various possible complexities which could arise might require a modified approach, involving additional or even alternative analyses.

Properties of each method: repeatability

The assessment of repeatability is an important aspect of studying alternative methods of measurement. Replicated measurements are, of course, essential for an assessment of repeatability, but to judge from the medical literature the collection of replicated data is rare. One possible reason for this will be suggested later.

Repeatability is assessed for each measurement method separately from replicated measurements on a sample of subjects. We obtain a measure of repeatability from the within-subject standard deviation of the replicates. The British Standards Institution (1979) define a coefficient of repeatability as "the value below which the difference between two single test results ... may be expected to lie with a specified probability; in the absence of other indications, the probability is 95 per cent". Provided that the differences can be assumed to follow a Normal distribution this coefficient is $2.83\sigma_r$, where σ_r is the within-subject standard deviation. σ_r must be estimated from a suitable experiment. For the purposes of the present analysis the standard deviation alone can be used as the measure of repeatability.

It is important to ensure that the within-subject repeatability is not associated with the size of the measurements, in which case the results of subsequent analyses might be misleading. The best way to look for an association between these two quantities is to plot the standard deviation against the mean. If there are two replicates x_1 and x_2 then this reduces to a plot of $|x_1 - x_2|$ against $(x_1 + x_2)/2$. From this plot it is easy to see if there is any tendency for the amount of variation to change with the magnitude of the measurements. The correlation coefficient could be tested against the null hypothesis of $r = 0$ for a formal test of independence.

If the within-subject repeatability is found to be independent of the size of the measurements, then a one-way analysis of variance can be performed. The residual standard deviation is an overall measure of repeatability, pooled across subjects.

If, however, an association is observed, the results of an analysis of variance could be misleading. Several approaches are possible, the most appealing of which is the transformation of the data to remove the relationship. In practice the logarithmic transformation will often be suitable. If the relationship can be removed, a one-way analysis of variance can be carried out. Repeatability can be described by calculating a 95 per cent range for the difference between two replicates. Back-transformation provides a measure of repeatability in the original units. In the case of log transformation the repeatability is a percentage of the magnitude of the measurement rather than an absolute value. It would be preferable to carry out the same transformation for measurement by each method, but this is not essential, and may be totally inappropriate.

If transformation is unsuccessful, then it may be necessary to analyse data from a restricted range of measurements only, or to subdivide the scale into regions to be analysed separately. Neither of these approaches is likely to be particularly satisfactory. Alternatively, the repeatability can be defined as a function of the size of the measurement.

Properties of each method: other considerations

Many factors may affect a measurement, such as observer, time of day, position of subject, particular instrument used, laboratory, etc. The British Standards Institution (1979) distinguish between repeatability, described above, and reproducibility, "the value below which two single test results ... obtained under different conditions ... may be expected to lie with a specified probability". There may be difficulties in carrying out studies of reproducibility in many areas of medical interest. For example, the gestational age of a newborn baby could not be determined at different times of year or in different places. However, when it is possible to vary conditions, observers, instruments, etc., the methods described above will be appropriate provided the effects are random. When effects are fixed, for example when comparing an inexperienced observer and an experienced observer, the approach used to compare different methods, described below, should be used.

Comparison of methods

The main emphasis in method comparison studies clearly rests on a direct comparison of the results obtained by the alternative methods. The question to be answered is whether the methods are comparable to the extent that one might replace the other with sufficient accuracy for the intended purpose of measurement.

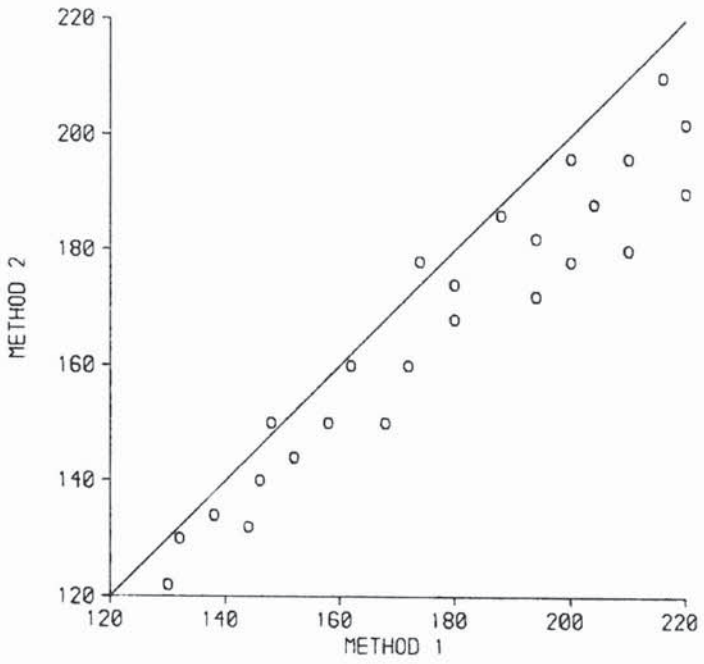

Fig. 1. Comparison of two methods of measuring systolic blood pressure.

The obvious first step, one which should be mandatory, is to plot the data. We first consider the unreplicated case, comparing methods A and B. Plots of this type are very common and often have a regression line drawn through the data. The appropriateness or regression will be considered in more detail later, but whatever the merits of this approach, the data will always cluster around a regression line by definition, whatever the agreement. For the purposes of comparing the methods the line of identity (A = B) is much more informative, and is essential to get a correct visual assessment of the relationship. An example of such a plot is given in Figure 1, where data comparing two methods of measuring systolic blood pressure are shown.

Although this type of plot is very familiar and in frequent use, it is not the best way of looking at this type of data, mainly because much of the plot will often be empty space. Also, the greater the range of measurements the better the agreement will appear to be. It is preferable to plot the difference between the methods (A – B) against (A + B)/2, the average. Figure 2 shows the data from Figure 1 replotted in this way. From this type of plot it is much easier to assess the magnitude of disagreement (both error and bias), spot outliers, and see whether there is any trend, for example an increase in A – B for high values. This way of plotting the data is a very powerful way of displaying the results of a method comparison study. It is closely related to the usual plot of residuals after model fitting, and the patterns observed may be similarly varied. In the example shown (Figure 2) there was a significant relationship between the method difference and the size of measurement ($r = 0.45$, $n = 25$, $P = 0.02$). This test is equivalent to a test of equality of the total variances of measurements obtained by the two methods (Pitman, 1939; see Snedecor and Cochran, 1967, pp. 195-7).

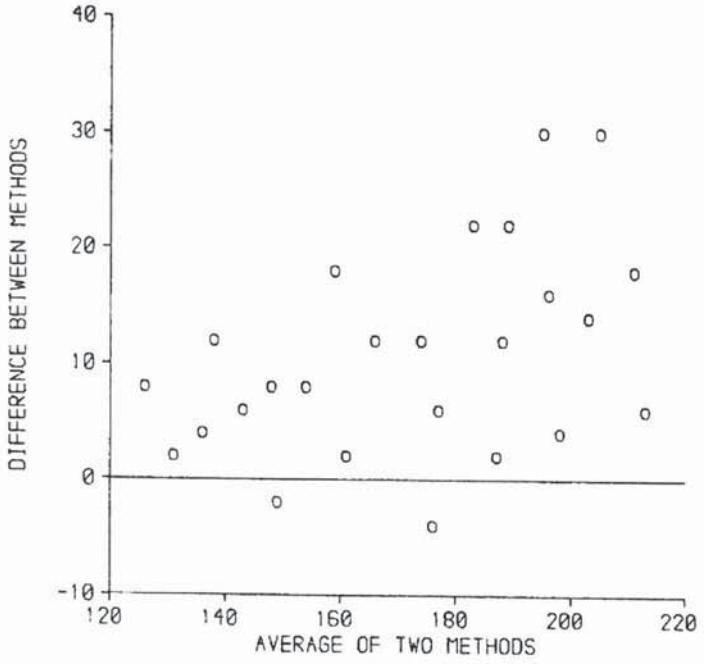

Fig. 2. Data from Figure 1 replotted to show the difference between the two methods against the average measurement.

As in the investigation of repeatability, we are looking here for the independence of the between-method differences and the size of the measurements. With independence the methods may be compared very simply by analysing the individual A – B differences. The mean of these differences will be the relative bias, and their standard deviation is the estimate of error. The hypothesis of zero bias can be formally examined by a paired t-test.

For the data of Carr *et al.* (1979) already discussed, the correlation of the individual differences with the average value was –0.36 ($P > 0.1$), so that an assumption of independence is not contradicted by the data. Figure 3 shows these data plotted in the suggested manner. Also shown is a histogram of the individual between-method differences, and superimposed on the data are lines showing the mean difference and a 95 per cent range calculated from the standard deviation. A composite plot like this is much more informative than the usual plot (such as Figure 1).

If there is an association between the differences and the size of the measurements, then as before, a transformation (of the raw data) may be successfully employed. In this case the 95 per cent limits will be asymmetric and the bias will not be constant. Additional insight into the appropriateness of a transformation may be gained from a plot of $|A - B|$ against $(A + B)/2$, if the individual differences vary either side of zero. In the absence of a suitable transformation it may be reasonable to describe the differences between the methods by regressing $A - B$ on $(A + B)/2$.

For replicated data, we can carry out these procedures using the means of the replicates. The estimate of bias will be unaffected, but the error will be reduced. We can estimate the standard deviation of the difference between individual measurements from the standard deviation of the difference between means by

$$\text{var}(A - B) = n \, \text{var}(\overline{A} - \overline{B})$$

where n is the number of replicates.

Within replicated data it may be felt desirable to carry out a two-way analysis of variance, with main effects of individuals and methods, in order to get better estimates. Such an analysis would need to be supported by the analysis of repeatability, and in the event of the two methods not being equally repeatable the analysis would have to be weighted appropriately. The simpler analysis of method differences (Figure 2) will also need to be carried out to ascertain that the differences are independent of the size of the measurements, as otherwise the answers might be misleading.

Alternative analyses

One alternative approach is least squares regression. We can use regression to predict the measurement obtained by one method from the measurement obtained by the other, and calculate a standard error for this prediction. This is, in effect, a calibration approach and does not directly answer the question of comparability. There are several problems that can arise, some of which have already been referred to. Regression does not yield a single value for relative precision (error), as this depends upon the distance from the mean. If we do try to use regression methods to assess comparability difficulties arise because there no obvious estimate of bias, and the parameters are difficult to interpret. Unlike the analysis of variance model, the parameters are affected by the range of the observations and for the results to apply generally the methods ought to have been compared on a random sample of subjects - a condition that will very often not be met. The problem of the underestimation (attenuation) of the slope of the regression line has been considered by Yates (Healy, 1958), but the other problems remain.

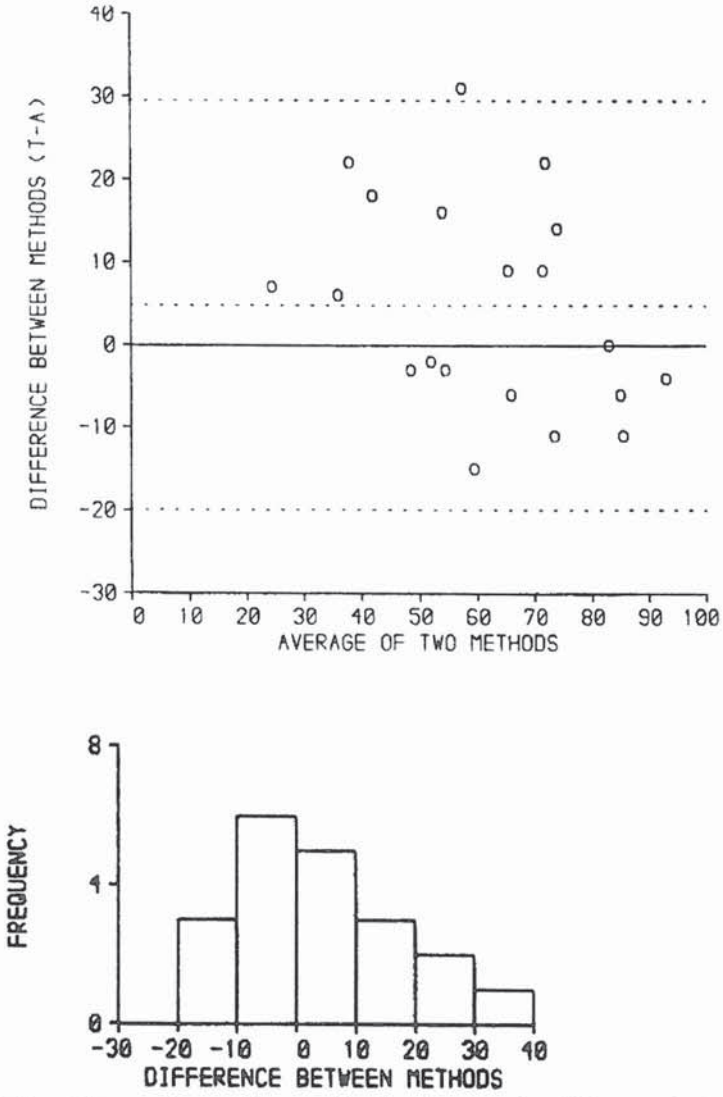

Fig. 3. Comparison of two methods of measuring left ventricular ejection fraction (Carr et al., 1979) replotted to show error and bias.

Other methods which have been proposed include principal component analysis (or orthogonal regression) and regression models with errors in both variables (structural relationship models) (see for example Carey *et al.*, 1975; Lawton *et al.*, 1979; Cornbleet and Gochman, 1979; Feldmann *et al.*, 1981). The considerable extra complexity of such analysis will not be justified if a simple comparison is all that is required. This is especially true when the results must be conveyed to and used by non-experts, e.g. clinicians. Such methods will be necessary, however, if it is required to

predict one measurement from the other - this is nearer to calibration and is not the problem we have been addressing in this paper.

Why does the comparison of methods cause so much difficulty?

The majority of medical method comparison studies seem to be carried out without the benefit of professional statistical expertise. Because virtually all introductory courses and textbooks in statistics are method-based rather than problem-based, the non-statistician will search in vain for a description of how to proceed with studies of this nature. It may be that, as a consequence, textbooks are scanned for the most similar-looking problem, which is undoubtedly correlation. Correlation is the most commonly used method, which may be one reason for so few studies involving replication, since simple correlation cannot cope with replicated data. A further reason for poor methodology is the tendency for researchers to imitate what they see in other published papers. So many papers are published in which the same incorrect methods are used that researchers can perhaps be forgiven for assuming that they are doing the right thing. It is to be hoped that journals will become enlightened and return papers using inappropriate techniques for reanalysis.
Another factor is that some statisticians are not as aware of this problem as they might be. As an illustration of this, the blood pressure data shown in Figures 1 and 2 were taken from the book *Biostatistics* by Daniel (1978), where they were used as the example of the calculation of the correlation coefficient. A counter-example is the whole chapter devoted to method comparison (by regression) by Strike (1981). More statisticians should be aware of this problem, and should use their influence to similarly increase the awareness of their non-statistical colleagues of the fallacies behind many common methods.

Conclusions

1. Most common approaches, notably correlation, do not measure agreement.
2. A simple approach to the analysis may be the most revealing way of looking at the data.
3. There needs to be a greater understanding of the nature of this problem, by statisticians, non-statisticians and journal referees.

Acknowledgements

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Appendix

Covariance of two methods of measurement in the presence of measurement errors
We have two methods A and B of measuring a true quantity T. They are related T by $A = T + \varepsilon_A$ and $B = T + \varepsilon_B$, where ε_A and ε_B are experimental errors. We assume that the errors have mean zero and are independent of each other and of T, and define the following variances:

$$\text{var}(T) = \sigma_T^2,\ \text{var}(\varepsilon_A) = \sigma_A^2,\ \text{and var}(\varepsilon_B) = \sigma_B^2$$

Now the covariance of A and B is given by

$$E(AB) - E(A)E(B) = E\{(T + \varepsilon_A)\ (T + \varepsilon_B)\} - E(T + \varepsilon_A)E(T + \varepsilon_B)$$
$$= E\{(T^2 + \varepsilon_A T + \varepsilon_B T + \varepsilon_A \varepsilon_B)\} - \{E(T) + E(\varepsilon_A)\}\{E(T) + E(\varepsilon_B)\}$$

But $E(\varepsilon_A) = E(\varepsilon_B) = 0$, and the errors and T are independent, so

$$E(\varepsilon_A)E(T) = E(\varepsilon_B)E(T) = 0$$

and

$$E(\varepsilon_A \varepsilon_B) = E(\varepsilon_A)E(\varepsilon_B) = 0$$

Hence $\text{cov}(A,B) = E(T^2) - \{E(T)\}^2 = \sigma_T^2$

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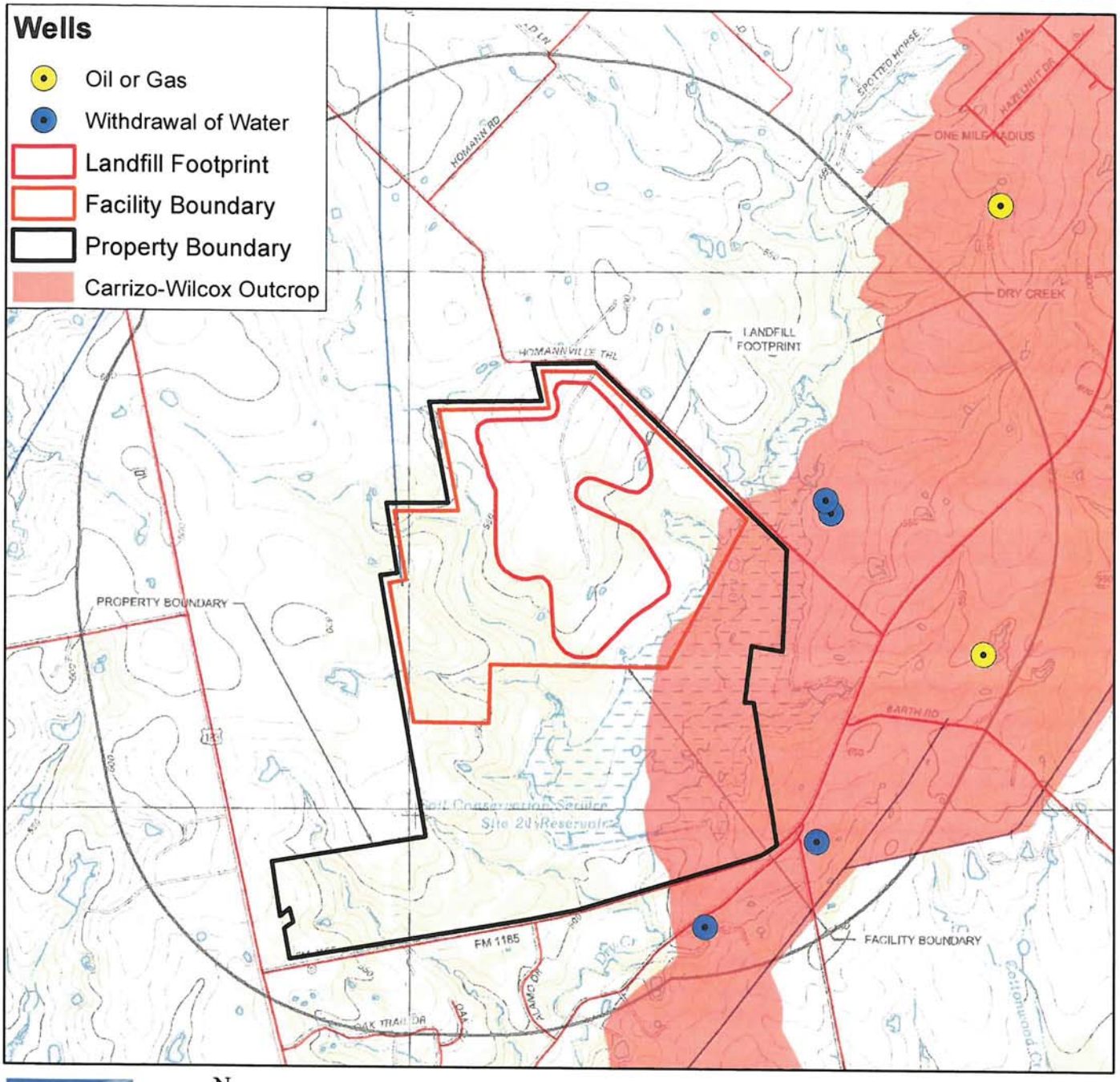


GLENROSE ENGINEERING

TBPE Firm No. F4092

Well locations based on GIS data from Texas Water Developoment Board accessed August 6, 2013.

Aquifer location based on GIS data from Texas Water Developoment Board accessed July 21, 2010.

Landfill location based on Biggs & Mathews Environmental Consulting Engineers, 13 Environmental Park General Topographic Map, drawing IA.3, August 30, 2013.

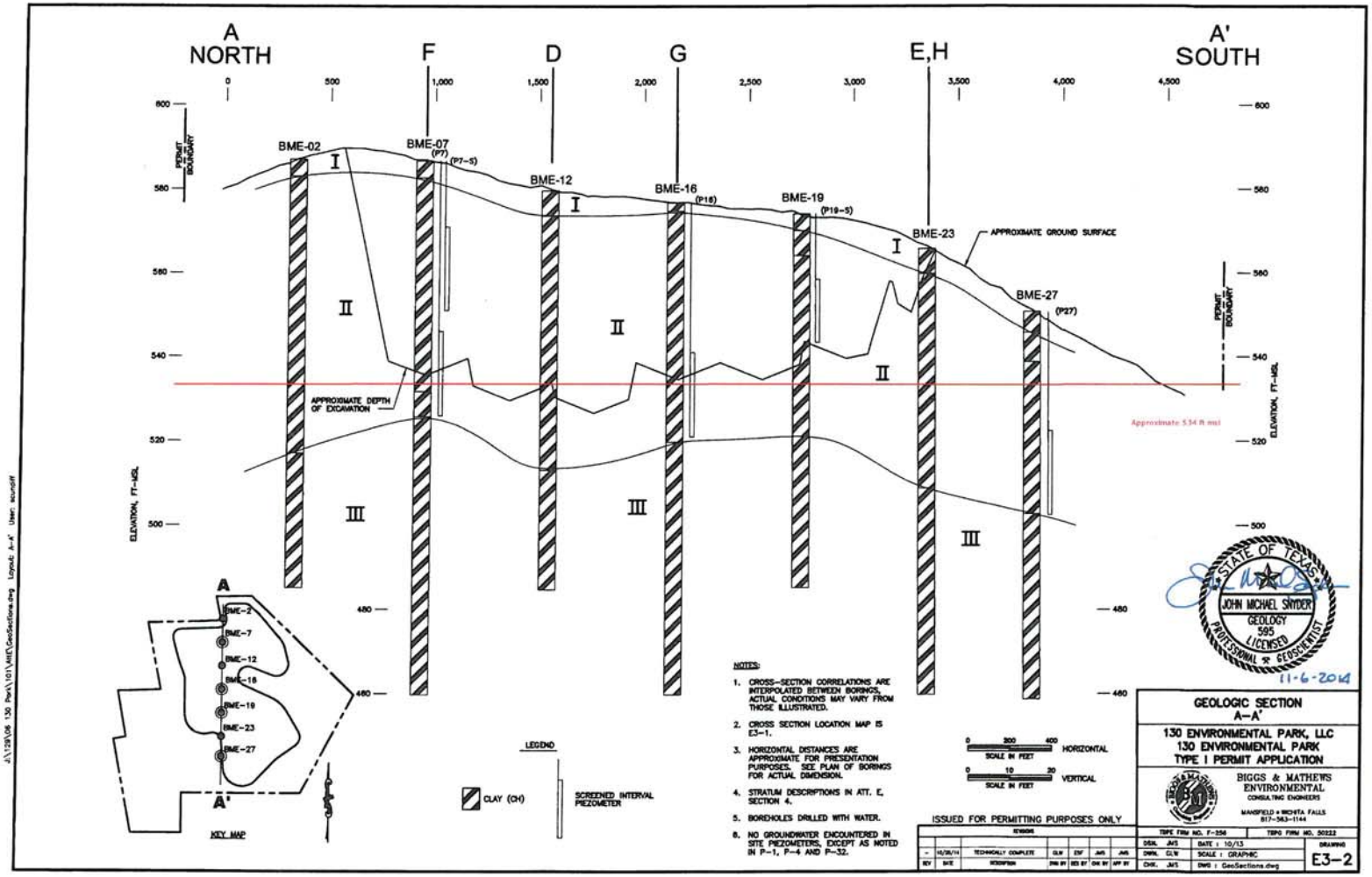
Major Aquifer Outcrop in the Vicinity of Proposed 130 Environmental Park LLC Landfill

STATE OF TEXAS
D. LAUREN ROSS
56647
LICENSED PROFESSIONAL ENGINEER

June 26, 2016

June 24, 2016

Protestants' Exhibit 5-AE: Landfill Excavation Cross Sections and Historical High Groundwater Level Measured in Applicant's Piezometers



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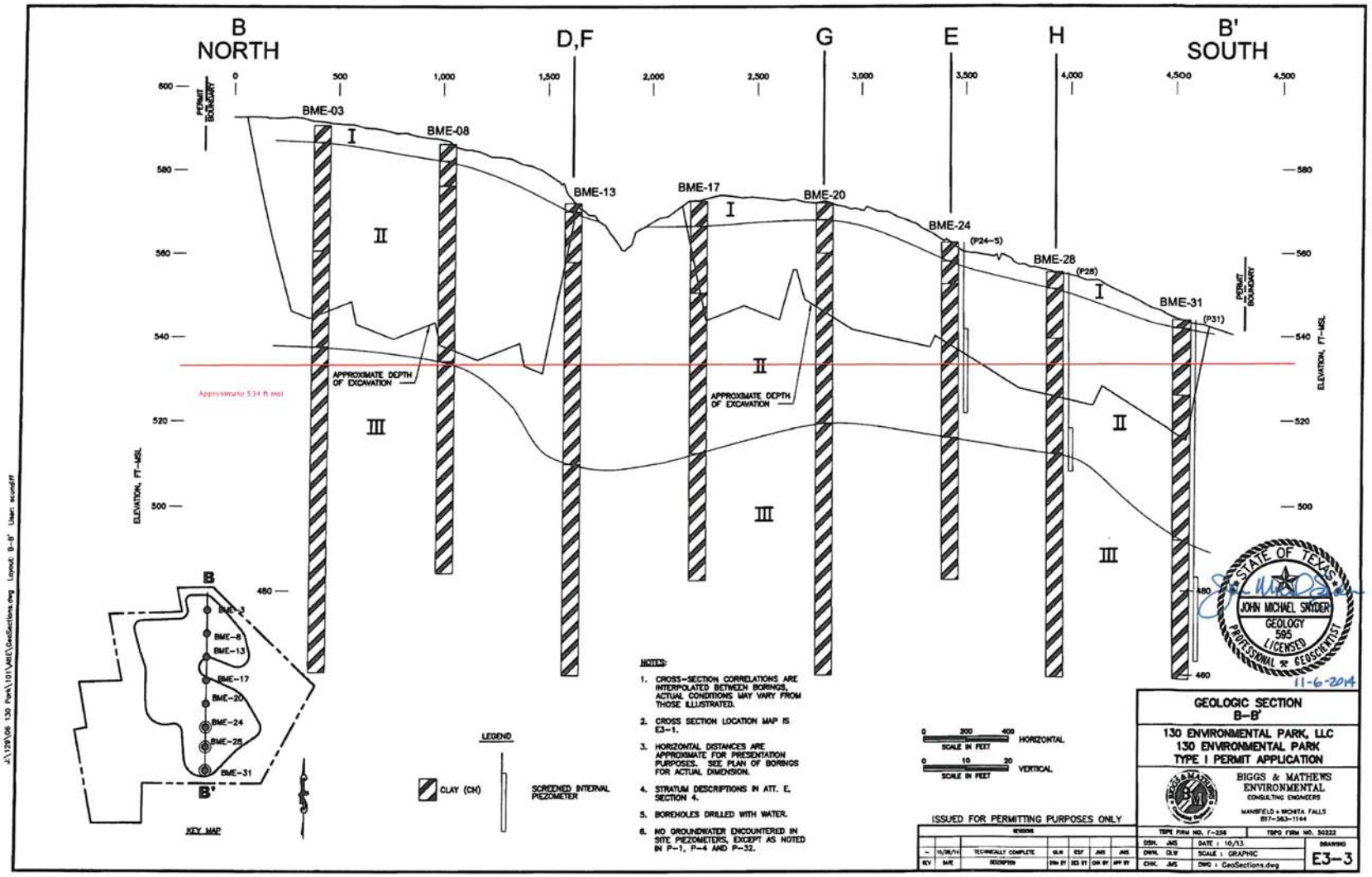

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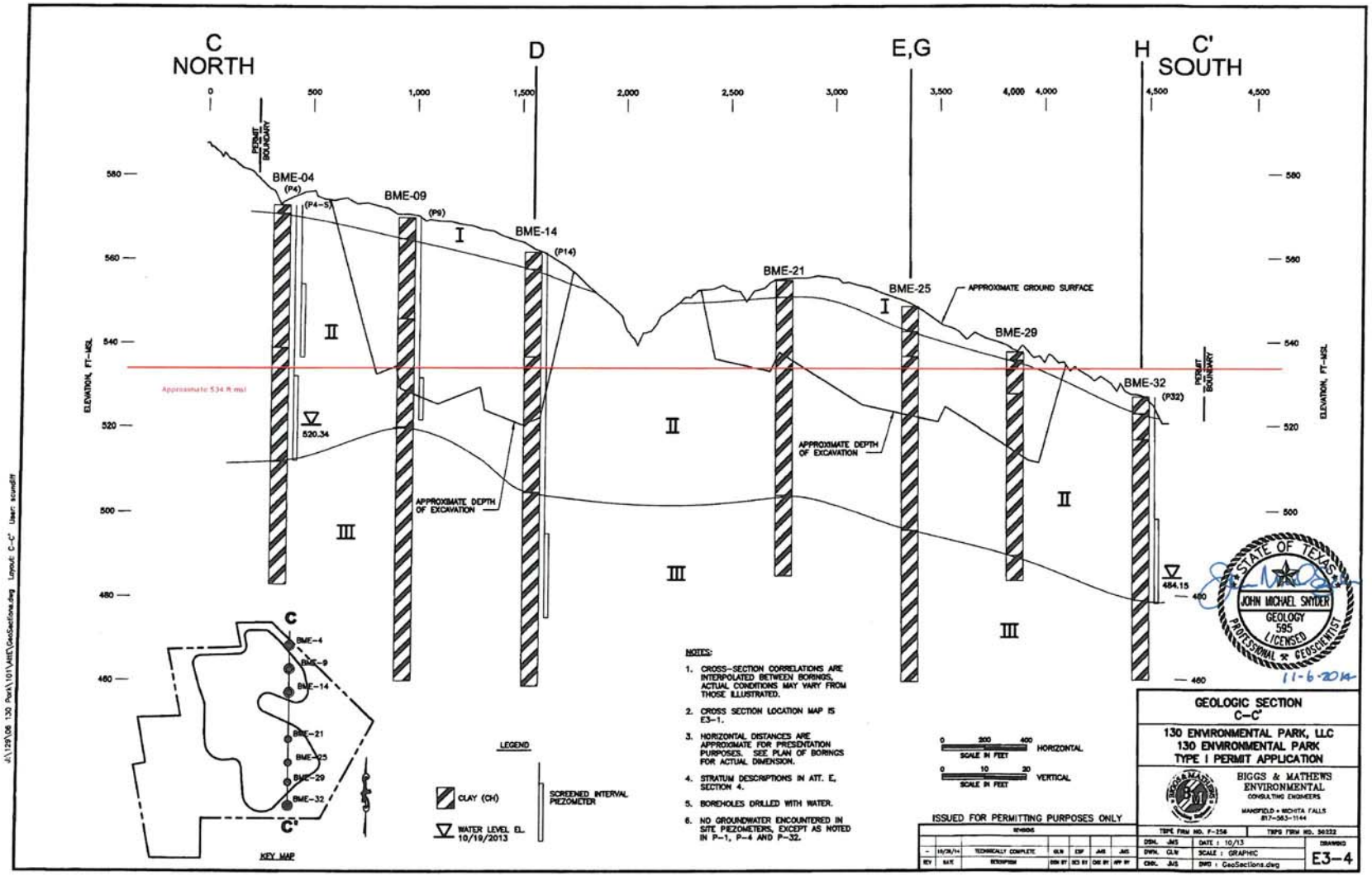

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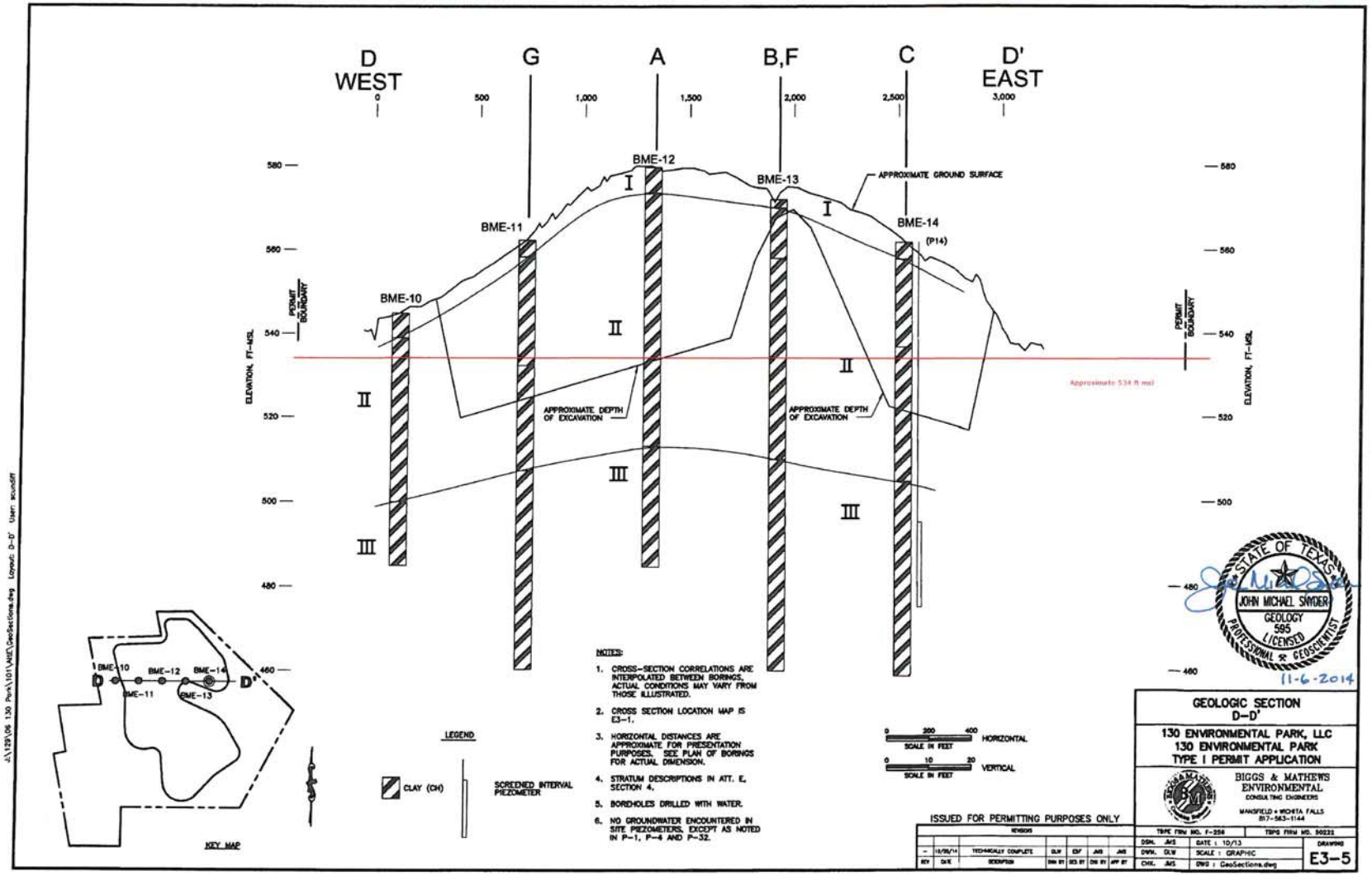

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June 26, 2016
sealed only for my additions in red

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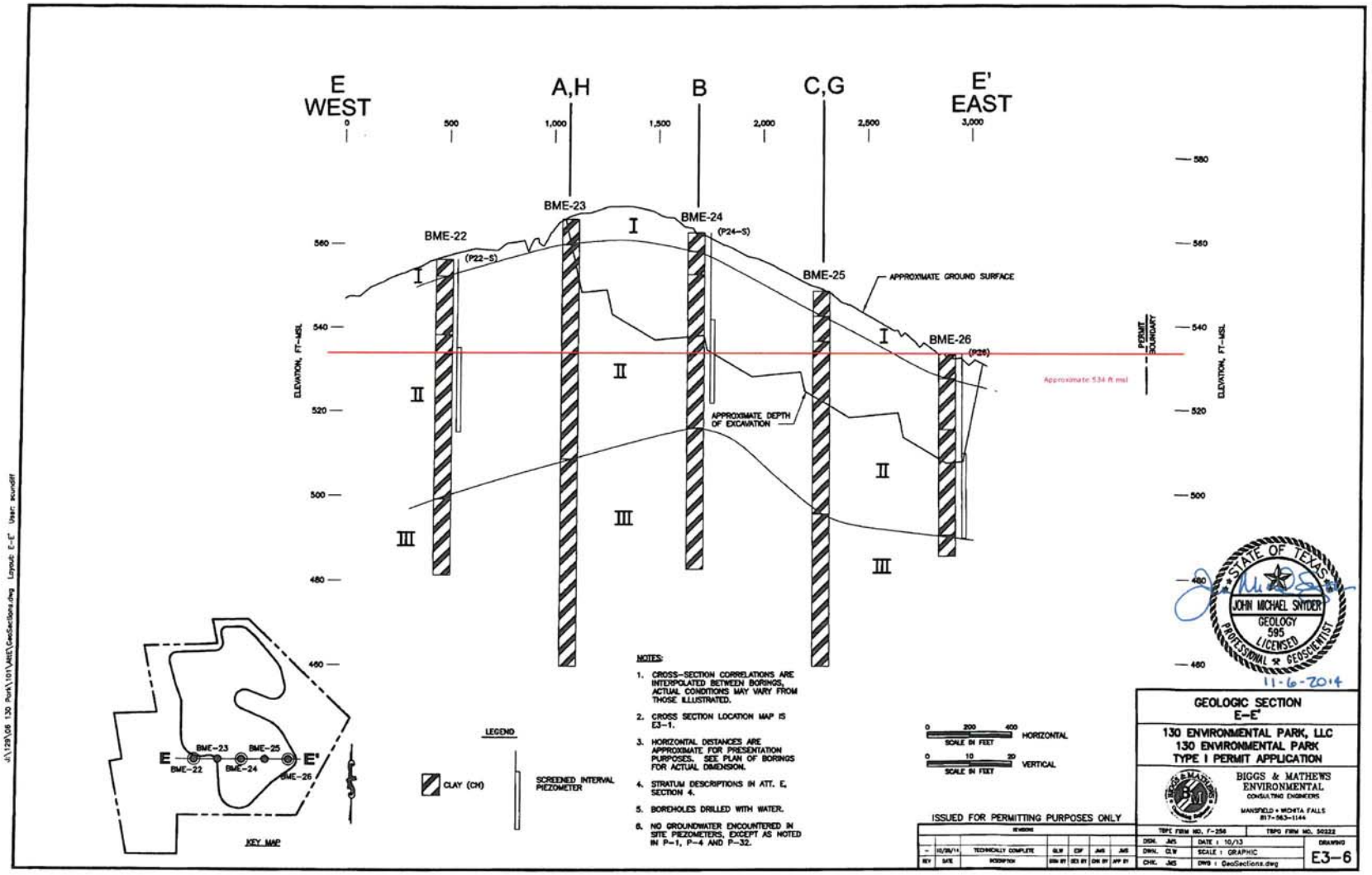

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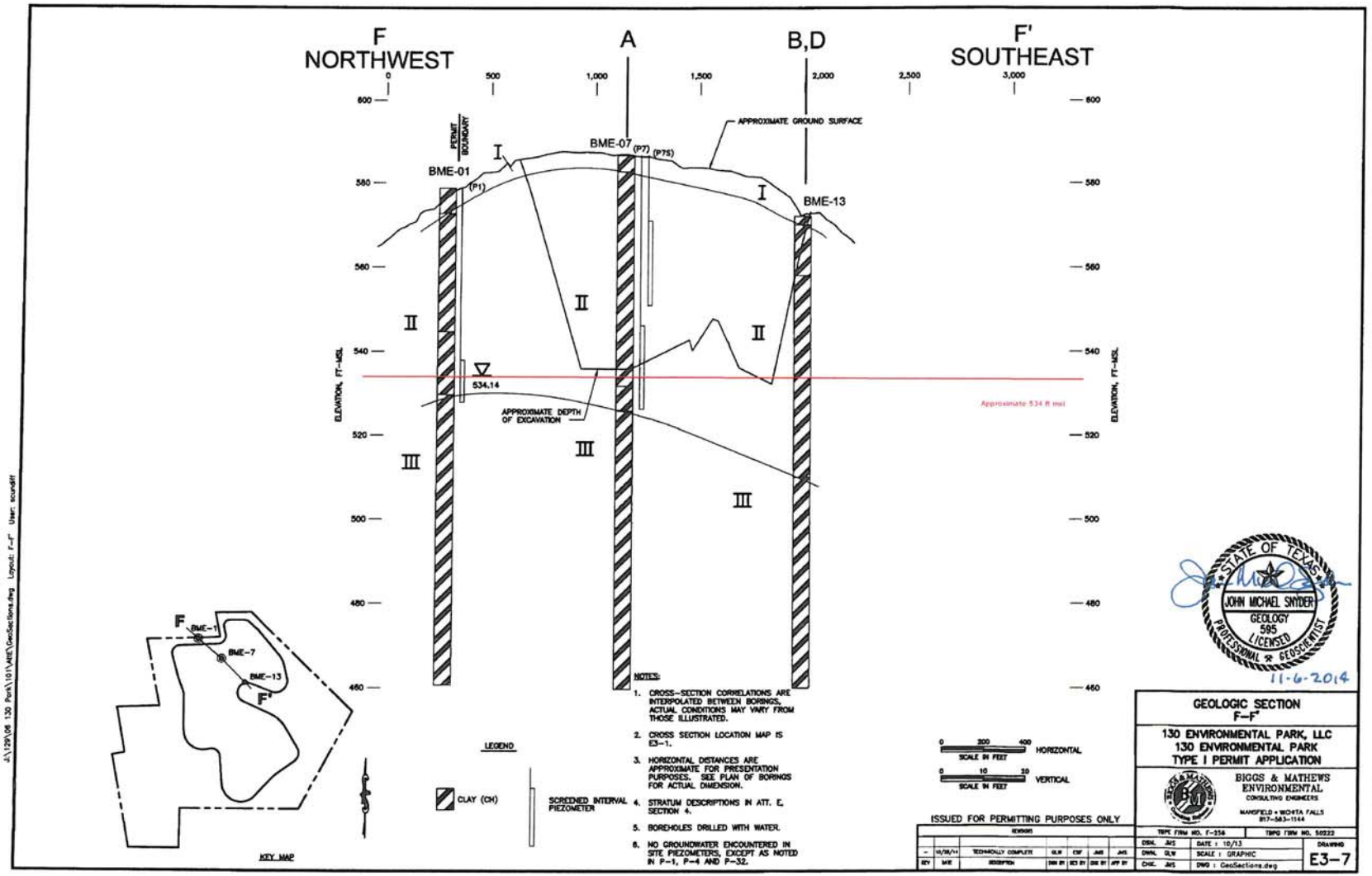

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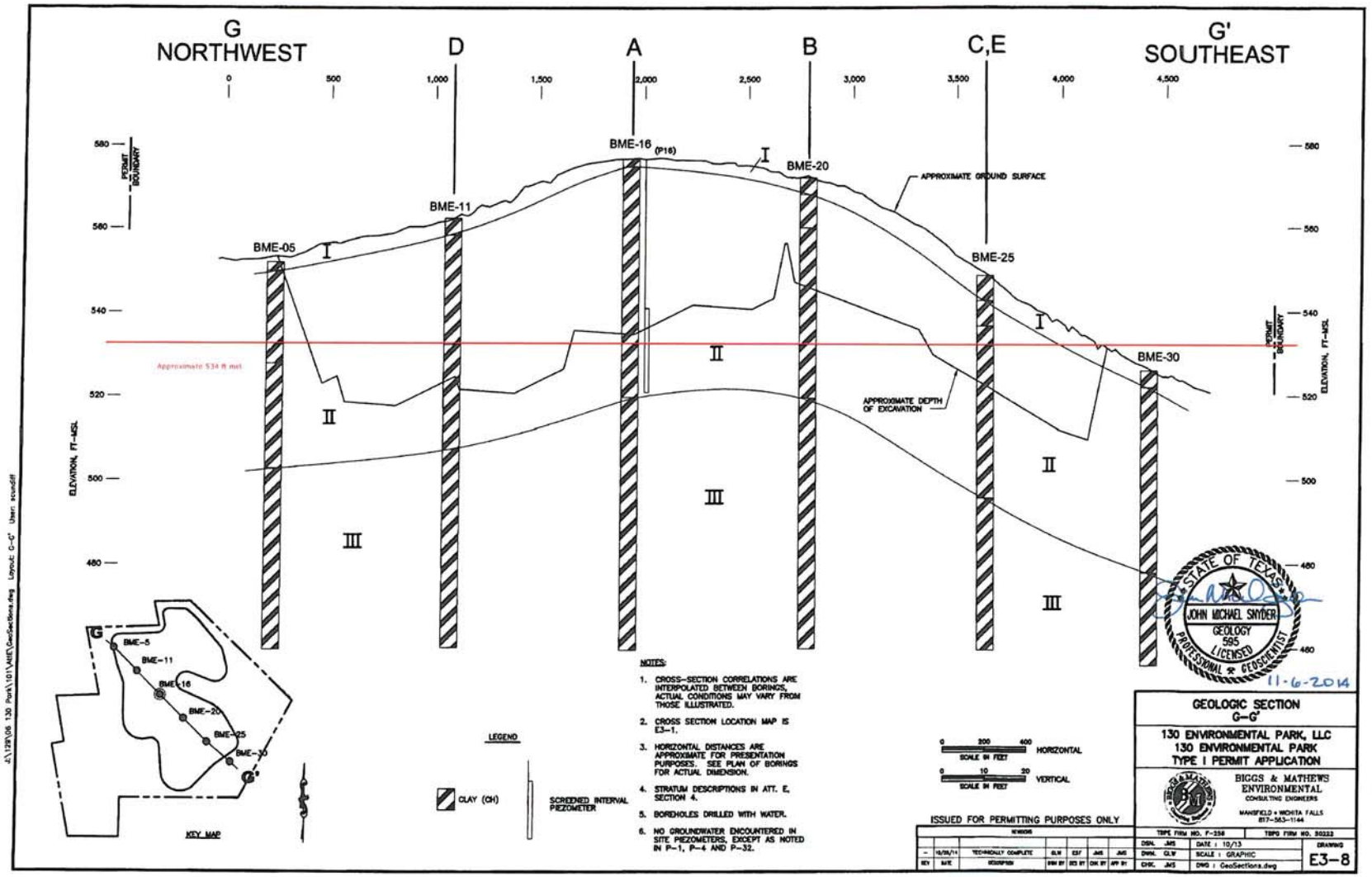

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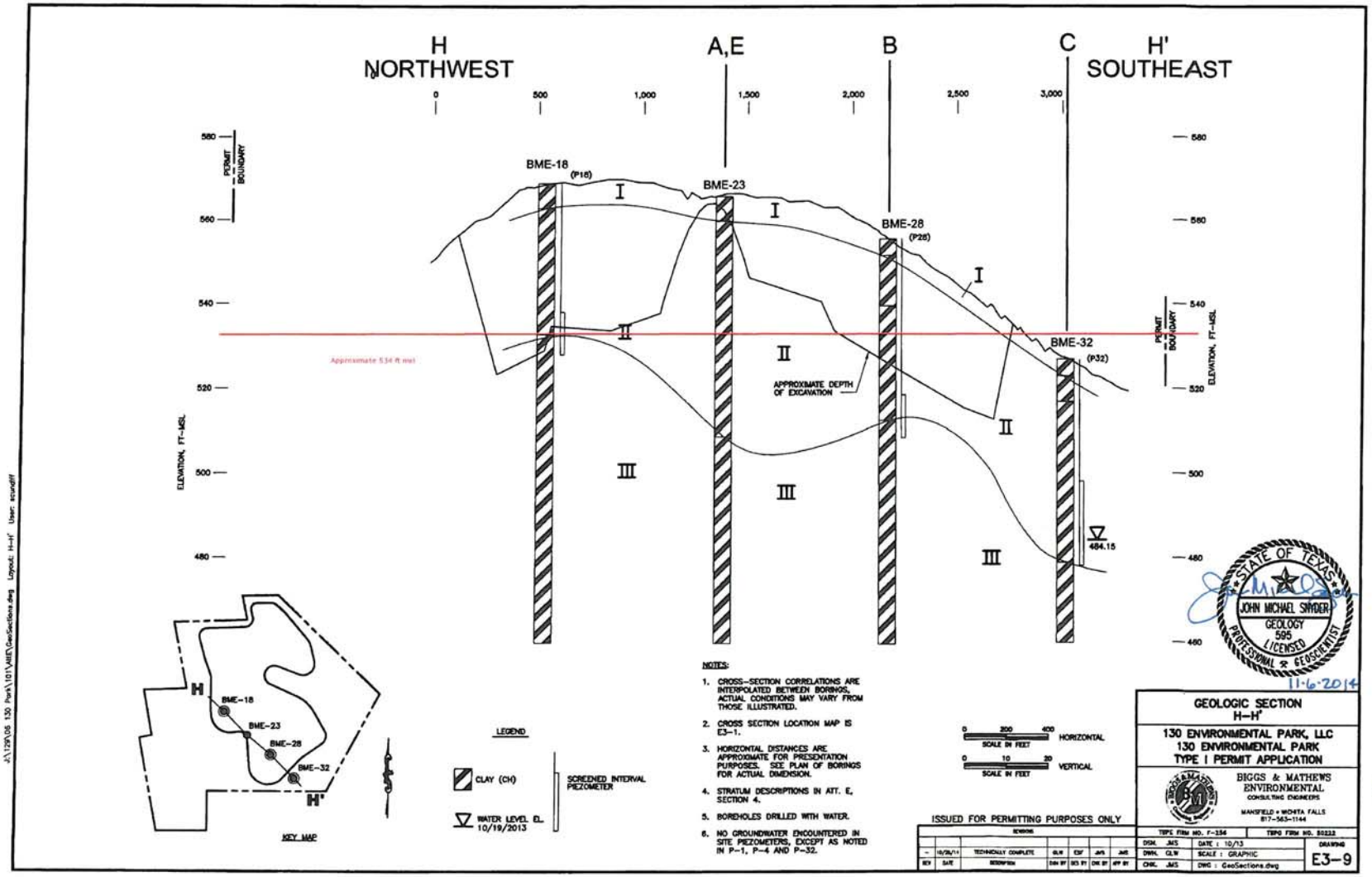

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I. **TITLE: Standards for Flood Risk Analysis and Mapping**

II. **DATE OF ISSUANCE: November 30, 2015**

III. **POLICY STATEMENT:** Flood risk projects, regulatory National Flood Insurance Program (NFIP) map changes and other Risk Mapping Analysis and Planning (Risk MAP) activities shall be performed in a consistent manner resulting in quality data and deliverables. The attached set of standards shall be followed in the delivery of Risk MAP.

IV. **PURPOSE:** The purpose of this policy is to enable consistent performance by identifying the standards that must be followed in the delivery of the Risk MAP program. These standards govern the performance of flood risk projects, processing of letters of map change and related Risk MAP activities. The Guidelines and Specifications for Flood Hazard Mapping Partners (G&S), used prior to this policy, was a mix of guidance and standards for Risk MAP activities. There were challenges associated with the G&S that included a lack of clarity, usability and organization of the document. In order to better align the G&S content to the flood hazard mapping program and Risk MAP, distinguish the policy from the guidance, and improve the usability, Risk Analysis Division has produced this compendium document of all standards applicable to flood risk projects, processing of letters of map change and the implementation of Risk MAP.

V. **SCOPE AND EXTERNAL AUDIENCE:** This policy is applicable to Federal Emergency Management Agency (FEMA) staff delivering Risk MAP, all mapping partners (contractors, cooperating technical partners, and other federal agencies) who perform flood risk projects on behalf of FEMA, and the NFIP. Additionally, this policy may be pertinent to states, tribes, communities, homeowners and their consultants who are interested in the flood insurance rate map process. Exceptions to conformance with individual standards are possible, but the established exception process must be followed and the appropriate decision-maker level within FEMA shall approve these exceptions.

VI. **AUTHORITY:** The mapping program for the NFIP, implemented through Risk MAP, is established through The National Flood Insurance Act of 1968, as amended and the Biggert-Waters Flood Insurance Reform Act of 2012, as amended (42 U.S.C. 4001 *et seq.*). The mapping program is governed by the implementing regulations at 44 CFR parts 59-72. The statutes and regulations establish the core requirements for the mapping program.

This policy represents FEMA's interpretation of these statutory and regulatory requirements and/or sets forth standard operating procedures. The policy itself does not impose legally enforceable rights and obligations, but sets forth a standard operating

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procedure or agency practice that FEMA employees and contractors follow to be consistent, fair, and equitable in the implementation of the Agency's authorities.

These standards are to be applied in addition to the legal requirements set out in the applicable statutes and regulations. For the most part, the applicable statutory and regulatory requirements are not repeated in this policy. Readers must refer to the statutes and regulations in addition to these standards.

VII. OBJECTIVES: The standards attached to this document will:

1) Ensure consistency in the deliverables of all flood risk projects so that they can support the NFIP and all of its stakeholders.
2) Ensure a standard level of quality is met for all deliverables of a flood risk project.
3) Provide appropriate flexibility to FEMA Regional Offices and Mapping Partners to accommodate regional and local variability across the country.
4) Enhance the credibility of the NFIP and all flood risk mapping efforts.

VIII. DEFINITIONS:

Flood risk projects are projects implemented under the Risk MAP program to engage with communities and provide flood risk information.

Guidance is a recommended method to meet the standard. Guidance assumes a working knowledge of common industry terminology and methodologies. Accepted approaches are not limited to this recommended approach; mapping partners may use other methods to meet or exceed the standard.

Guidelines and Standards Steering Committee is a team of FEMA headquarters and regional employees and contractors responsible for maintenance and coordination of Risk MAP standards and guidance.

Mapping Partners are FEMA Production and Technical Services Contractors, Cooperating Technical Partners, and other Federal Agencies performing tasks on a flood risk project.

Program standards are a required element that supports the vision, goals and objectives of the Program. Exceptions must be obtained through coordination with FEMA headquarters Risk Analysis Division leadership.

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Risk MAP is the FEMA program that maintains flood maps for the NFIP and engages with local governments to increase awareness of flood risk and provide flood risk information that leads to actions to reduce risk.

Standards exceptions are project-specific variances to Risk MAP standards, approved by appropriate Risk MAP officials.

Working standards are required elements of a project that are typically applied by specialists (such as engineers, planners, GIS specialists, etc.). A complete list of acronyms and abbreviations is attached as Appendix B.

IX. POLICY DETAILS: Flood risk projects, regulatory NFIP map changes and other Risk MAP activities must comply with the standards attached as Appendix A.

Standards must be implemented based on the effective date and implementation description. New standards may be implemented sooner in coordination with the FEMA Project Officer and Contracting Officer's Representative.

FEMA publishes substantial additional guidance to support implementation of and compliance with these standards. Users of these standards should also reference this guidance published on FEMA's web site.

X. ROLES & RESPONSIBILITIES: The FEMA Federal Insurance and Mitigation Administration (FIMA) Risk Analysis Division Director is responsible for approving exceptions to program standards.

FEMA Mitigation Regional Risk Analysis Branch Chiefs are responsible for approving exceptions to working standards and concurring on exceptions for program standards for flood risk projects or Risk MAP services managed by the FEMA Regional offices.

FIMA headquarters subject matter experts are responsible for approving exceptions to working standards and concurring on exceptions for program standards for flood risk projects or Risk MAP services managed by FEMA headquarters.

FEMA employees responsible for Risk MAP delivery are responsible for complying with the standards.

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Mapping partners performing flood risk projects and reviewing requests for changes to maps are responsible for complying with the standards while performing work on the project.

XI. MONITORING AND EVALUATION: Compliance will be monitored through the Risk MAP Quality Assurance Management Plan.

The Guidelines and Standards Steering Committee is responsible for maintenance of the policy. Updates to the standards will be published on a semi-annual basis.

XII. RESPONSIBLE OFFICE: The Federal Insurance and Mitigation Administration Risk Analysis Division is responsible for this policy.

XIII. SUPERSESSION:
This policy updates and supersedes the **Standards for Flood Risk Analysis and Mapping – FP 204-078-1 (Rev 3)** approved July 31, 2015.

Each standard is listed with the effective date for that standard and an implementation description that describes how it is applied to work in progress.

The changes with this revision are:

SID #	Change	Description
6	Revised	Clarifies that the CNMS technical reference must be followed for validation and needs assessment.
139	Revised	Replaces the term "equilibrium condition" for beach nourishment project areas with more appropriate terminology.
40, 43, 46	Revised	Updates to transition FEMA's elevation requirements for new lidar to match the new USGS Specification which is the base standard for the 3D Elevation Program.
47, 48	Rescinded	Updates to transition FEMA's elevation requirements for new lidar to match the new USGS Specification which is the base standard for the 3D Elevation Program.
618	New	New standard to clarify requirements for LOMRs to update the NFHL, including strengthening the requirement for an area of revision to be included in the NFHL regardless of whether the LOMR has a map attachment showing an area of revision or not.

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SID #	Change	Description
619	New	New standard that updates the requirements for revisions involving the Primary Frontal Dune in coastal areas.

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FP 204-078-1 (Rev 4)

FEDERAL INSURANCE AND MITIGATION ADMINISTRATION POLICY

XIV. REVIEW DATE: This policy will be reviewed 3 years from the date of issuance in accordance with Directive 112-12.

Roy E. Wright
Deputy Associate Administrator for Insurance and Mitigation
Federal Insurance and Mitigation Administration

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Appendix A
Standards for Flood Risk Analysis and Mapping

SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
1	4/1/2003	Existing standard. Already implemented.	Project Initiation	Program Standard	All Flood Risk Projects and LOMCs must be tracked in the MIP.
2	4/1/2003	Existing standard. Already implemented.	Project Initiation	Working Standard	A Project Management Team shall be formed as soon as a Flood Risk Project is initiated, and this team shall manage the project for its entire lifecycle.
3	4/1/2003	Existing standard. Already implemented.	Project Initiation	Program Standard	When a community is initially considered for a Flood Risk Project involving a new or revised flood hazard analysis, FEMA must establish and maintain a community case file per 44 CFR 66.3.
4	10/1/2009	Existing standard. Already implemented.	Project Initiation	Program Standard	All newly initiated Flood Risk Projects must be watershed-based, with the exception of coastal and small-scale Flood Risk Projects related to levee accreditation status.
5	7/13/2010	Existing standard. Already implemented.	Project Planning	Working Standard	No flooding source will receive a lower level of regulatory flood map product than what currently exists on effective maps.
6	11/30/2015	Effective Immediately.	CNMS	Working Standard	Both flood hazard validation and needs assessment processes must follow the CNMS Technical Reference and the results must be stored within the national CNMS database.
7	6/17/2011	Existing standard. Already implemented.	CNMS	Working Standard	Community-specific requests to update the FIRM outside of the NVUE validation process and LOMR process must be documented in the CNMS database as mapping requests for FEMA Regional review and consideration.
8	6/17/2011	Existing standard. Already implemented.	CNMS	Working Standard	The CNMS database shall be updated for engineering reference information, validation status, and map issues throughout all pertinent phases of the Flood Risk Project.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
9	6/17/2011	Existing standard. Already implemented.	CNMS	Program Standard	The CNMS database shall be the sole authority for reporting flood map update needs.
10	6/17/2011	Existing standard. Already implemented.	CNMS	Working Standard	For a studied flooding source to go from 'UNVERIFIED' to '"VALID" status within the CNMS database, the flooding source must be re-analyzed.
11	6/17/2011	Existing standard. Already implemented.	CNMS	Working Standard	When the last assessment date of the Modernized or Paper Inventory exceeds 5 years, the Validation Status shall be changed by FEMA HQ or its designee to 'Unknown' and shall require reassessment.
12	6/17/2011	Existing standard. Already implemented.	Project Planning	Program Standard	Each fiscal year, the Regions shall have a plan to evaluate all CNMS flooding sources within a 5-year period.
13	6/17/2011	Existing standard. Already implemented.	CNMS	Working Standard	NVUE status must be reported by each FEMA Region to FEMA HQ at least quarterly.
14	6/17/2011	Existing standard. Already implemented.	Project Planning	Working Standard	Regional decisions to prioritize, assess, and perform engineering analyses along various flooding sources must be supported by the data contained in CNMS.
15	4/1/2003	Existing standard. Already implemented.	Coordination	Working Standard	FEMA shall provide technical and programmatic assistance and prepare responses to inquiries received from Mapping Partners, NFIP constituents and other interested project stakeholders.
16	6/11/2011	Existing standard. Already implemented.	Project Planning	Program Standard	Each flooding source must be evaluated in CNMS at least once within a 5-year period.
17	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Project Planning	Program Standard	Discovery is a mandatory element of all Flood Risk Projects, and must be conducted on the same scale at which the Flood Risk Project is initiated. All watershed-based Discovery must be initiated at a geographic footprint no larger than the HUC-8 level.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
18	7/1/2011	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	All communities and tribes must be given an opportunity to review and make corrections to any data and information collected during Discovery prior to distribution of final Discovery products.
19	7/1/2011	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	Flood Risk Project stakeholders must be contacted prior to the Discovery Meeting.
20	7/1/2011	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	Discovery must engage all communities and stakeholder organizations within the project area and must engage practitioners across relevant disciplines.
21	7/1/2011	Existing standard. Already implemented.	Discovery	Working Standard	The types of data and information obtained during Discovery must demonstrate a holistic picture of flooding issues, flood risk, and flood mitigation priorities, opportunities, efforts and capabilities.
22	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Project Planning	Program Standard	Decisions to perform additional analyses, data development activities, and/or community engagement within the Flood Risk Project area must be supported by the outcomes from Discovery. These decisions shall be communicated to project stakeholders prior to executing those activities.
23	7/1/2011	Existing standard. Already implemented.	Discovery	Working Standard	A pre-meeting Discovery Map and Report that incorporates appropriate background research must be provided to the communities and Tribes prior to the Discovery Meeting and presented at the Discovery Meeting to facilitate discussions.
24	7/1/2011	Existing standard. Already implemented.	Discovery	Working Standard	A post-meeting Discovery Map and Report will be provided to the communities and Tribes after the Discovery Meeting.
26	7/1/2011	Existing standard. Already implemented.	Discovery	Working Standard	A Discovery Report must include a section listing the data and information collected, when they were received, data sources, and an analysis of the data and information. The Post-Meeting Report must include the outcomes and decisions made at the Discovery Meeting.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
27	7/1/2011	Existing standard. Already implemented.	Discovery	Program Standard	A Discovery Meeting with project stakeholders is a required activity of Discovery.
29	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Stakeholder Engagement	Program Standard	During Discovery, data must be identified that illustrates potential changes in flood elevation and mapping that may result from the proposed project scope. If available data does not clearly illustrate the likely changes, an analysis is required that estimates the likely changes. This data and any associated analyses must be shared and results must be discussed with stakeholders.
30	7/1/2011	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	The Flood Risk Project scope of work must be developed in coordination with project stakeholders. The purchased Flood Risk Project scope of work must be shared with project stakeholders.
31	7/1/2011	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	Discovery must include a discussion with stakeholders regarding risk identification, mitigation capabilities and actions, planning, and risk communication.
33	7/1/2011	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	For coastal Flood Risk Projects that will begin with a storm surge analysis, stakeholder coordination must occur by the end of the storm surge study effort and continue throughout the remainder of the coastal Flood Risk Project.
34	7/1/2011	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	When storm surge analyses are included in a Flood Risk Project, Discovery efforts must include a discussion of how storm surge estimates have changed since the effective Flood Risk Project.
35	7/1/2011	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	The FEMA Regional Office must be consulted as to how Tribal Nations should be included in the overall Discovery efforts.
36	1/1/2013	Existing standard. Already implemented.	CNMS	Program Standard	A CNMS database that is compliant with the CNMS Technical Reference must be updated and submitted at the completion of Discovery or Project Initiation, at Preliminary, and at Revised Preliminary if applicable, based on the information and data collected.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
40	11/30/2015	All FY16 task orders that include new lidar collection.	Elevation Data	Program Standard	New elevation data purchased by FEMA must comply with the current USGS National Geospatial Program Base Lidar Specification Version 1.2, except hydroflattening is not required and a classified point cloud and a bare earth DEM deliverable are not required.
41	4/1/2003	Existing standard. Already implemented.	Elevation Data	Working Standard	For areas within the Continental United States field surveys and aerial data acquisition must be referenced to the North American Vertical Datum of 1988 (NAVD88) and the North American Datum 1983 (NAD83) and connected to the NSRS.
42	4/1/2003	Existing standard. Already implemented.	Elevation Data	Working Standard	All ground and structure surveys must be certified by a registered professional engineer or a licensed land surveyor.
43	11/30/2015	Effective Immediately.	Elevation Data	Working Standard	Existing topographic data leveraged by FEMA must have documentation that it meets the following vertical accuracy requirements:

Vertical Accuracy Requirements based on Flood Risk and Terrain Slope within the Floodplain being Mapped

Level of Flood Risk	Typical Slopes	Specification Level	Vertical Accuracy: 95% Confidence Level (FVA or NVA) / (CVA or VVA)	LiDAR Nominal Pulse Spacing (NPS)
High (Deciles 1,2,3)	Flattest	Highest	24.5 cm / 36.3 cm	≤ 2 meters
High (Deciles 1,2,3)	Rolling or Hilly	High	49.0 cm / 72.6 cm	≤ 2 meters
High (Deciles 2,3,4,5)	Hilly	Medium	98.0 cm / 145 cm	≤ 3.5 meters
Medium (Deciles 3,4,5,6,7)	Flattest	High	49.0 cm / 72.6 cm	≤ 2 meters
Medium (Deciles 3,4,5,6,7)	Rolling	Medium	98.0 cm / 145 cm	≤ 3.5 meters
Medium (Deciles 3,4,5,6,7)	Hilly	Low	147 cm / 218 cm	≤ 5 meters
Low (Deciles 7,8,9,10)	All	Low	147 cm / 218 cm	≤ 5 meters

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
44	1/1/2013	Existing standard. Already implemented.	Elevation Data	Working Standard	FEMA requires all elevation data to be processed to the bare earth terrain in the vicinity of floodplains that will require hydraulic modeling.
45	9/27/2010	Existing standard. Already implemented.	Elevation Data	Working Standard	FEMA does not require the elevation data to be hydro-flattened, as specified in USGS Lidar Specification.
46	11/30/2015	All FY16 task orders that include new lidar collection.	Elevation Data	Working Standard	When a classified point cloud and a Digital Elevation Model (DEM) deliverable are included in a new elevation data collection, checkpoints for Vegetated Vertical Accuracy (VVA) must fall within the DEM footprint.
49	1/1/2013	Existing standard. Already implemented.	Elevation Data	Working Standard	All FEMA funded aerial mapping must be certified by a licensed professional or certified photogrammetrist.
50	11/1/2009	Existing standard. Already implemented.	2D Models	Working Standard	The digital terrain model input for a two-dimensional model must cover the entire 2D study area and the derivation or development of the grid must be clearly documented.
54	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	H&H Analyses	Working Standard	Where flood elevations are produced from a hydraulic model, they can be published as BFEs unless the responsible engineer documents why they should not be issued.
56	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Alluvial Fan	Program Standard	Written approval from the FEMA Regional Risk Analysis Branch Chief regarding the alluvial fan methodology must be obtained before the commencement of full analysis. To inform this decision, sufficient field data and analysis and records of community engagement relative to the scope and methodology must be provided.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
57	11/1/2009	Existing standard. Already implemented.	Engineering	Program Standard	The regulatory and non-regulatory flood risk products must be based on H&H or coastal analyses using existing ground conditions in the watershed and floodplain. The multiple profile and floodway runs must have the same physical characteristics in common for existing ground conditions. However, a community may choose to include flood hazard information that is based on future conditions on a FIRM (shown as shaded Zone X); in an FIS Report; or non-regulatory products in addition to the existing-conditions.
59	11/1/2009	Existing standard. Already implemented.	H&H Analyses	Working Standard	Hydrologic and hydraulic analyses must be calibrated using data from well-documented flood events, if available.
61	11/1/2009	Existing standard. Already implemented.	Engineering	Program Standard	Engineering analyses must be documented and easily reproducible and must include study methods, reasoning for method selection, input data and parameters, sources of data results, and justifications for major changes in computed flood hazard parameters.
62	1/1/2013	Existing standard. Already implemented.	H&H Analyses	Program Standard	New or updated flood hazard data used for the regulatory products must be supported by modeling or sound engineering judgment and all regulatory products must be in agreement.
65	11/1/2009	Existing standard. Already implemented.	BFEs	Working Standard	BFEs must agree with those of other contiguous studies of the same flooding source within 0.5 foot, unless it is demonstrated that it would not be appropriate. Please see 44 CFR 65.6a(2).
66	11/1/2009	Existing standard. Already implemented.	Flood Profiles	Working Standard	Each modeled split or diverted flow path must be plotted with individual Flood Profiles.
67	11/1/2009	Existing standard. Already implemented.	2D Models	Working Standard	Grids or cells must not be artificially removed when two- or three-dimensional models are used.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
69	11/1/2009	Existing standard. Already implemented.	Floodway	Program Standard	Floodway surcharge values must be between zero and 1.0 ft. If the State (or other jurisdiction) has established more stringent regulations, these regulations take precedence over the NFIP regulatory standard. Further reduction of maximum allowable surcharge limits can be used if required or requested and approved by the communities impacted.
70	11/1/2009	Existing standard. Already implemented.	Floodway	Working Standard	If a stream forms the boundary between two or more States and/or tribes, either the 1.0-foot maximum allowable rise criterion or existing floodway agreements between the parties shall be used.
71	11/1/2009	Existing standard. Already implemented.	Floodway	Working Standard	Revised floodway data must match any effective floodways at the limits of the Flood Risk Project.
72	11/1/2009	Existing standard. Already implemented.	Floodway	Working Standard	An equal conveyance reduction method must be used to establish the minimal regulatory floodway.
73	11/1/2009	Existing standard. Already implemented.	Floodway	Working Standard	To calculate floodways using methodologies other than steady-state, one-dimensional models, pre-approval must be received from the FEMA Project Officer and impacted communities and states with floodway authorities.
74	7/31/2013	For all ongoing and newly initiated projects.	H&H Analyses	Program Standard	The hydrologic, hydraulic, and coastal analyses and the final regulatory products must be certified by a registered professional engineer.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
75	11/1/2009	Existing standard. Already implemented.	FIS Tables	Working Standard	For each stream with cross sections where a floodway was determined under the scope of work, a Floodway Data Table compliant with the FIS Report Technical Reference must be prepared as part of the hydraulic analysis. The Floodway Data Table must contain an entry for each lettered, mapped cross section that includes the following information: • Cross-section identification shown in a georeferenced spatial file; • Stream or profile baseline station of the cross section; • Width of the floodway at the cross section; • Wetted area of the cross section under encroached conditions; • Average velocity of the floodwaters at the cross section under encroached conditions; • The greater of BFEs from all flooding sources, including from backwater, affecting the cross section (regulatory elevation); • The BFE from the existing conditions model (without-floodway elevation); • The BFE from the encroached existing conditions model (with-floodway elevation); and • Difference between with- and without-floodway elevations (surcharge).
76	11/1/2009	Existing standard. Already implemented.	H&H Analyses	Working Standard	If previously-modeled storage areas are removed or filled, the models must be updated to reflect the loss in storage.
77	11/1/2009	Existing standard. Already implemented.	Floodway	Working Standard	Floodway computations for tributaries must be developed without consideration of backwater from confluences.
78	11/1/2009	Existing standard. Already implemented.	Flood Profiles	Working Standard	The water-surface profiles of different flood frequencies must not cross one another.

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79	11/1/2009	Existing standard. Already implemented.	Flood Profiles	Working Standard	Water-surface elevations shown on the Flood Profiles shall not rise from an upstream to downstream direction.
80	11/1/2009	Existing standard. Already implemented.	Profile Baseline	Working Standard	If a flow path other than the stream centerline is more representative of the direction of flow, the case must be documented and the flow path shown and labeled on the FIRM as the "Profile Baseline". Flow distances in one-dimensional models must be referenced to the profile baseline.
81	11/1/2009	Existing standard. Already implemented.	H&H Analyses	Working Standard	Ineffective and non-conveyance areas must be designated to reflect the actual conditions (such as topography and surface roughness) as closely as practical.
82	9/28/2010	Existing standard. Already implemented.	Project Management	Program Standard	Final invoices shall not be paid until a TSDN is submitted, and certification is provided that contract or grant requirements are met.
83	9/28/2010	Existing standard. Already implemented.	Project Planning	Program Standard	The FEMA Regional staff initiating a Flood Risk Project shall first engage all stakeholders in order to fully understand the impacted communities, leverage other FEMA activities in the area, and thereby avoid duplication of benefits through funding to CTPs.

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84	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	H&H Analyses	Program Standard	All riverine engineering Flood Risk Projects shall consist of a hydraulic model with multiple frequencies: 0.2 percent, 1-percent, 2-percent, 4-percent, and 10-percent-annual-chance exceedance events. **In addition, the "1-percent plus" flood elevation shall be modeled for all riverine** analyses. The 1% plus flood elevation is defined as a flood elevation derived by using discharges that include the average predictive error for the regression equation discharge calculation for the Flood Risk Project. This error is then added to the 1% annual chance discharge to calculate the new 1% plus discharge. The upper 84-percent confidence limit is calculated for Gage and rainfall-runoff models for the 1% annual chance event. **The "1-percent plus" flood elevation must be shown on the Flood Profile in the** FIS Report to best understand and communicate the uncertainty of the flood elevation. **The mapping of the "1-percent plus" floodplain** is optional and will only be produced when it is determined to be appropriate.
85	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Project Planning	Working Standard	Deviations from standards must be approved by FEMA, tracked for exception reporting, and documented.
86	2/1/2007	Existing standard. Already implemented.	Coastal	Working Standard	For coastal Flood Risk Projects, wave runup analyses shall compute the wave runup elevation as the value exceeded by 2 percent of the runup events.
87	5/1/2012	Existing standard. Already implemented.	Coastal	Working Standard	For coastal Flood Risk Projects, intermediate data submissions to FEMA are required at key milestones during the coastal analysis process.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
88	5/1/2012	Existing standard. Already implemented.	Coastal	Working Standard	All coastal processes and flooding sources that contribute to the 1-percent-annual-chance flood condition both at a regional and local scale must be considered.
89	2/1/2007	Existing standard. Already implemented.	Coastal	Working Standard	For coastal Flood Risk Projects, non-levee coastal structures must be evaluated and the profile adjusted as necessary to reflect expected storm impacts on the structure for the purpose of establishing appropriate risk zone determinations for NFIP maps.
90	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Engineering	Program Standard	Methods and models used to evaluate the flood hazard must be technically reliable, must be appropriate for flood conditions and produce reasonable results. All computer models must adhere to 44 CFR 65.6 a(6).
91	11/1/2004	Existing standard. Already implemented.	Coastal	Program Standard	For Pacific coastal Flood Risk Projects, VE Zones are identified using one or more of the following criteria for the 1% flood conditions: 1. The wave runup zone occurs where the (eroded) ground profile is 3.0 feet or more below the TWL. 2. The wave overtopping splash zone is the area landward of the crest of an overtopped barrier, in cases where the potential wave runup exceeds the barrier crest elevation by 3.0 feet or more. 3. The high-velocity flow zone is landward of the overtopping splash zone (or area on a sloping beach or other shore type), where the product of depth of flow times the flood velocity squared is greater than or equal to 200 ft^3/sec^2. 4. The breaking wave height zone occurs where 3-foot or greater wave heights could occur (this is the area where the wave crest profile is 2.1 feet or more above the static water elevation). 5. The primary frontal dune zone, as defined in 44 CFR 59.1 of the NFIP regulations.
92	5/1/2012	Existing standard. Already implemented.	Coastal	Working Standard	For coastal Flood Risk Projects, regional surge and wave model performance shall be successfully validated for the Flood Risk Project area.

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93	11/1/2004	Existing standard. Already implemented.	Engineering	Program Standard	Flood Risk Projects shall use the best available, quality-assured data that meets the needs of the study methodology.
96	5/1/2012	Existing standard. Already implemented.	Coastal	Working Standard	Coastal analyses shall not account for future impacts due to long term erosion. Episodic, storm-induced erosion must be included in the flood hazard analysis.
98	2/1/2007	Existing standard. Already implemented.	Coastal	Program Standard	For Atlantic and Gulf of Mexico Flood Risk Projects, VE zones shall be mapped when one or more of the following criteria for the base flood conditions exist: • The wave runup zone occurs where the (eroded) ground profile is 3.0 feet or more below the 2-percent wave runup elevation; • The wave overtopping splash zone is the area landward of the crest of an overtopped barrier, in cases where the overtopping rate exceeds 1 cfs/ft; • The breaking wave height zone occurs where 3-foot or greater wave heights could occur; • The primary frontal dune zone, as defined in 44 CFR 59.1 of the NFIP regulations under *Coastal High Hazard Area and Primary Frontal Dune.*
99	4/1/2003	Existing standard. Already implemented.	Shallow Flooding	Working Standard	Areas of shallow flooding shall not have modeled/computed floodways due to the inherent uncertainties associated with their flow patterns. However, communities can choose to have administrative floodways for such areas.
100	4/1/2003	Existing standard. Already implemented.	Shallow Flooding	Working Standard	Ponding areas with depths between 1 and 3 feet shall be designated and delineated as Zone AH.
101	4/1/2003	Existing standard. Already implemented.	Shallow Flooding	Working Standard	Sheet runoff areas shall be delineated as Zone AO with average flooding depths above the ground surface, rounded to the nearest whole foot, indicated on the work map or digital GIS data.
103	4/1/2003	Existing standard. Already implemented.	PMR	Working Standard	For areas where new regulatory maps are being issued, flood hazard information on the effective NFIP map (i.e., FIRM, FBFM, FHBM) that is not being updated through a separate flood hazard analysis or floodplain boundary redelineation shall be "carried over" to the new or updated FIRM.

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104	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Redelineation	Working Standard	Redelineation shall only be used when the terrain source data is better than effective and the stream reach is classified as VALID in the CNMS database.
105	4/1/2003	Existing standard. Already implemented.	BFEs	Working Standard	BFE placement standard exceptions may be made where BFEs are expressed in metric increments, such as in Puerto Rico.
106	11/30/2014	Implemented for all projects beginning data development after effective date	BFEs	Working Standard	BFEs for ponding and lacustrine areas must be expressed to the 10th of a foot if they have been calculated to that level of precision; otherwise they should be shown as whole-foot rounded elevations. Unrevised lake and ponding elevations may be converted to 10th foot elevations if supported by technical data on a project-by project basis in coordination with the FEMA Project Officer. BFEs for coastal flood zones must be shown as whole foot elevations.
107	4/1/2003	Existing standard. Already implemented.	BFEs	Working Standard	BFEs must be shown within 1% annual chance floodplains; the exception shall be for Zone A, Zone V, Zone AO and Zone A99.
108	4/1/2003	Existing standard. Already implemented.	Floodway	Working Standard	Regulatory floodways must be mapped within the 1-percent-annual-chance floodplain and must meet the minimum standards outlined in Paragraph 60.3(d)(3) of the NFIP regulations.
109	4/1/2003	Existing standard. Already implemented.	Floodplain Boundaries	Working Standard	Stream channel boundaries or centerlines must be shown within the identified 1-percent-annual-chance floodplain; if a regulatory floodway is developed, the stream must be shown within the regulatory floodway boundaries.
110	4/1/2003	Existing standard. Already implemented.	Project Planning	Program Standard	Flooding sources with contributing drainage area less than 1 square mile and/or with an average flood depth of less than one foot shall not be included in the Flood Risk Project scope of work, unless they have been analyzed on the effective FIRM or a justified need is identified during Discovery.

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<table>
<tr><th>SID #</th><th>Effective Date</th><th>Implementation Description</th><th>Category</th><th>Standard Type</th><th>Standard</th></tr>
<tr><td>111</td><td>7/31/2013</td><td>Implemented with all new flood risk projects initiated in FY13.</td><td>Project Planning</td><td>Program Standard</td><td>At the conclusion of a flood risk project, all SFHA designations—existing, revised, and new—in the project area must be supported by documentation or agreed to by the community.</td></tr>
<tr><td>112</td><td>1/10/2010</td><td>Existing standard. Already implemented.</td><td>FBS</td><td>Working Standard</td><td>For all Flood Risk Projects contracted in 2006 and beyond, all floodplain boundaries for new or revised flooding sources within the PMR footprint shall pass the Floodplain Boundary Standard.</td></tr>
<tr><td>113</td><td>1/10/2010</td><td>Existing standard. Already implemented.</td><td>FBS</td><td>Working Standard</td><td>The flood risk class must be determined for each flooding source to identify what Floodplain Boundary Standard must be met and what level of analysis is required.
<table>
<tr><th rowspan="2">Risk Class</th><th rowspan="2">Characteristics</th><th colspan="2">Delineation Reliability of the floodplain boundary per study methodology[1]</th></tr>
<tr><th>Zone A</th><th>All Other Zones</th></tr>
<tr><td>A</td><td>High population and densities within the floodplain and/or high anticipated growth</td><td>+/- 1/2 contour 95%</td><td>+/- 1.0 foot / 95%</td></tr>
<tr><td>B</td><td>Medium populate and densities within the floodplain and/or modest anticipated growth</td><td>+/- 1/2 contour 90%</td><td>+/- 1.0 foot / 90%</td></tr>
<tr><td>C</td><td>Low population and densities within the floodplain, small or no anticipated growth</td><td>+/- 1/2 contour 85%</td><td>+/- 1.0 foot / 85%</td></tr>
<tr><td>D</td><td>Undetermined Risk, likely subject to flooding</td><td>N/A</td><td>N/A</td></tr>
<tr><td>E</td><td>Minimal risk of flooding; area not studied</td><td>N/A</td><td>N/A</td></tr>
</table>
[1]The difference between the ground elevation (defined from topographic data) and the computed flood elevation</td></tr>
</table>

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114	1/10/2010	Existing standard. Already implemented.	FBS	Working Standard	A horizontal tolerance of +/- 38 feet will be used to determine the compliance with the vertical tolerances defined for each risk class. This horizontal tolerance will address varying floodplain delineation techniques (automated versus non-automated) and map scale limitations.
115	1/10/2010	Existing standard. Already implemented.	FBS	Working Standard	For the FBS audit, the terrain data source that was used to create the flood hazard boundary must be used to conduct the audit.
118	3/1/2006	Existing standard. Already implemented.	Vertical Datum	Program Standard	For areas within the continental United States, all new flood maps and updates must be referenced to NAVD88.
119	4/1/2003	Existing standard. Already implemented.	Vertical Datum	Working Standard	If the final average countywide or flooding source-based datum conversion value is less than +/- 0.1 foot, the datum conversion shall be considered to be executed and the flood elevations for those flooding sources on the FIRM, Flood Profiles, and in the FIS Report tables shall not be adjusted.
120	4/1/2003	Existing standard. Already implemented.	Vertical Datum	Working Standard	The published flood elevations for all flooding sources within a community must be referenced to a single vertical datum.
121	4/1/2003	Existing standard. Already implemented.	Vertical Datum	Working Standard	The vertical datum conversion factors shall be applied to flood elevations reported on the FIRM, Flood Profiles shown in the FIS Report, and all data tables in the FIS Report that report flood elevations. All unrevised hydraulic models and supporting backup information shall also be clearly labeled in the Technical Support Data Notebook (TSDN) to indicate that the FIRM and FIS Report reflect a datum conversion, and document the process used to determine the applied conversion factor.

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122	7/31/2013	Implemented for all projects beginning data development in FY13.	Vertical Datum	Working Standard	Either a single countywide vertical datum conversion factor or an average flooding source-based conversion factor must be used for a grouping of flooding sources, for individual flooding sources, or for flooding source segments.
123	1/1/2013	Existing standard. Already implemented.	Vertical Datum	Working Standard	A single countywide vertical datum conversion factor shall be applied when the maximum offset from the average conversion factor does not exceed 0.25 foot.
124	7/31/2013	Implemented for all projects beginning data development in FY13.	Vertical Datum	Working Standard	When calculating a single countywide vertical datum conversion, USGS topographic Quadrangle corners falling within the land area of the county must be used to calculate the vertical datum conversion factor.
125	7/31/2013	Implemented for all projects beginning data development in FY13.	Vertical Datum	Working Standard	When a single countywide conversion is not possible, an average vertical datum conversion factor shall be calculated using a flooding source-based method for a grouping of flooding sources, an individual flooding source, or segments of a flooding source. When a flooding source-based conversion is executed, 3 evenly distributed points along each flooding source (or segment of a flooding source) shall be selected to be included the datum conversion calculation. The maximum offset from the average conversion factor determined for the flooding source, grouping of flooding sources or flooding source segment may not exceed 0.25 foot.
126	1/1/2013	Existing standard. Already implemented.	Vertical Datum	Working Standard	All flood elevations must be tied in when performing datum conversions.

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127	1/1/2013	Existing standard. Already implemented.	FIS Tables	Working Standard	The datum conversion factors (countywide or stream-based) must be clearly documented in the FIS Report tables.
128	11/1/2009	Existing standard. Already implemented.	2D Models	Working Standard	For floodplains mapped from 2-D models, separate Flood Profiles for significant flow paths must be created.
131	11/1/2009	Existing standard. Already implemented.	2D Models	Working Standard	All non-conveyance areas considered in the model must be mapped.
132	11/1/2009	Existing standard. Already implemented.	Floodway	Working Standard	The regulatory floodway must be terminated at the boundary of the VE or V Zone, or where the mean high tide exceeds the 1-percent-annual-chance riverine flood elevation, whichever occurs further upstream.
133	11/1/2009	Existing standard. Already implemented.	Floodplain Boundaries	Program Standard	Floodplain boundaries of the 1-percent-annual-chance flood must be delineated. If it is calculated, the 0.2-percent-annual-chance flood must be delineated.
134	6/17/2011	Existing standard. Already implemented.	Redelineation	Working Standard	If the re-delineation topographic data indicates that the effective hydraulic analyses are no longer valid, further actions must be coordinated with the FEMA Project Officer and the CNMS database must be updated.
136	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	National Flood Hazard Layer (NFHL)	Program Standard	RFHL to NFHL submissions must pass NFHL QC checks at submission and study data must be submitted before the study effective date.
137	2/1/2007	Existing standard. Already implemented.	Coastal	Working Standard	Redelineation of coastal flood hazard areas requires the revision of the 1-percent-annual-chance SFHA boundary, the 0.2%-annual-chance floodplain boundary, and the primary frontal dune delineation.
138	1/1/2013	Existing standard. Already implemented.	Coastal	Working Standard	Coastal Flood Risk Projects shall produce, at a minimum, a 1%-annual-chance and 0.2%-annual-chance floodplain and base flood elevations that include the contribution of wave effects.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
139	11/30/2015	Effective Immediately.	Coastal	Program Standard	For coastal Flood Risk Projects, where topographic data reflects a temporary disturbance due to recent beach nourishment and/or dune construction projects, and beach berm or dune geometry are not representative of natural conditions nor have long-standing vegetative cover as per 44CFR 65.11, the data shall be adjusted to be representative of natural conditions prior to conducting the storm-induced erosion and onshore wave hazard analyses.
140	4/1/2003	Existing standard. Already implemented.	Shallow Flooding	Working Standard	Shallow flooding areas shall not contain non-SFHA islands based on small scale topographic variations.
141	4/1/2003	Existing standard. Already implemented.	Ice Jam	Working Standard	In regions of the United States where ice jams are typical, the project shall include investigation of historical floods for evidence of ice-jam contribution and coordination of the methodology with the impacted communities and State as part of the Discovery process.
142	4/1/2003	Existing standard. Already implemented.	Ice Jam	Working Standard	Where ice jams occur, backwater effects must be taken into account.
143	4/1/2003	Existing standard. Already implemented.	Ice Jam	Working Standard	The appropriate methodology for the floodway designation in areas mapped with an ice-jam analysis shall be determined in coordination with the community.
145	1/1/2013	Existing standard. Already implemented.	FIS Report	Working Standard	A transect location map must be provided in the FIS Report narrative if transects are not shown on the FIRM.
146	2/17/2000	Existing standard. Already implemented.	Coordination	Working Standard	FEMA must be notified of any potential floodplain management violations identified through the submittal of new or revised flood hazard data. Pending mapping changes affected by the potential violation will be suspended until the issue is resolved.
147	4/1/2003	Existing standard. Already implemented.	Base Map	Working Standard	The minimum resolution requirement for raster data files (ortho-imagery) is 1-meter ground distance.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
148	4/1/2003	Existing standard. Already implemented.	Base Map	Working Standard	The minimum horizontal positional accuracy for new FIRM base map hydrographic and transportation features is the NSSDA radial accuracy of 38 feet.
149	4/1/2003	Existing standard. Already implemented.	Base Map	Working Standard	The base map used for the Flood Insurance Rate Map must clearly show sufficient current ground features to enable clear interpretation of the flood hazard data displayed on the base map.
150	4/1/2003	Existing standard. Already implemented.	Map Format and Layout	Working Standard	The FIRM paneling scheme shall follow that used by the USGS for the 7.5-minute-series quadrangle, or subdivisions thereof.
151	4/1/2003	Existing standard. Already implemented.	Map Format and Layout	Working Standard	All digital FIRMs must be oriented so that grid north points to the top of the map sheet.
152	8/23/2005	Existing standard. Already implemented.	GDC	Program Standard	Geospatial data for use in Flood Risk Projects must be coordinated, collected, documented and reported with standardized, complete and current information in compliance with Federal geospatial data reporting standards.
153	1/1/2013	Existing standard. Already implemented.	GDC	Working Standard	Details of cost, leverage, and project scope must be reported to FEMA's geospatial data tracking systems.
154	8/23/2005	Existing standard. Already implemented.	GDC	Program Standard	All unnecessary duplication of Federal, State or local mapping efforts must be avoided.
155	1/1/2011	Existing standard. Already implemented.	GDC	Working Standard	State Geospatial Data Coordination Procedures and Points of Contact must be reported to FEMA as new sources of Federal or State data are identified.
157	1/1/2011	Existing standard. Already implemented.	Project Planning	Program Standard	FEMA will not provide funding for new base map data collection as part of a specific Flood Risk Project.

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158	8/23/2005	Existing standard. Already implemented.	Elevation Data	Program Standard	Elevation data created using FEMA funding must allow unlimited free distribution by FEMA and partners.
161	1/1/2013	Existing standard. Already implemented.	Data Capture	Program Standard	All deliverables and supporting data must be uploaded to the MIP as each workflow step is completed for each project task. If any of these data are modified subsequently, the revised data must be uploaded to the MIP before the effective date of the FIRMs or the completion of the project, if no regulatory products are produced.
163	4/1/2003	Existing standard. Already implemented.	Prelim Distribution	Working Standard	The Preliminary digital FIRM Database shall be distributed for review with the Preliminary FIRM and FIS Report.
164	4/1/2003	Existing standard. Already implemented.	Prelim Distribution	Program Standard	The FEMA Regional office must approve distribution of preliminary and revised preliminary products.
165	4/1/2003	Existing standard. Already implemented.	Prelim Distribution	Program Standard	Preliminary/Revised Preliminary copies of the FIRM, FIS Report, SOMAs (if modified during Revised Preliminary), and Letters shall be distributed to the community CEO and floodplain administrator; State NFIP Coordinator; and other identified stakeholders as appropriate.
166	4/1/2003	Existing standard. Already implemented.	Prelim Distribution	Working Standard	Following issuance of the Preliminary copies of the FIRM and FIS Report, FEMA shall provide a period (usually 30 days) for community officials, community residents, and other interested parties / stakeholders to review the Preliminary copies of the FIRM and FIS Report.

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168	4/1/2003	Existing standard. Already implemented.	SOMA	Program Standard	All effective LOMCs located on affected FIRM panel(s) shall be reviewed and categorized: 1. through a draft SOMA before the Preliminary copies of the affected FIRM panel(s) are prepared and sent to the community for review and comment; 2. through a revised draft SOMA before Revised Preliminary copies of the affected FIRM panel(s) are prepared and sent to the community for review and comment; 3. through a Final SOMA before the LFD letter is sent to the community; and 4. through a revalidation letter before the effective date of the new or revised FIRM panels.
169	4/1/2003	Existing standard. Already implemented.	LOMR Incorporation	Program Standard	All LOMRs issued during post-preliminary prior to the LOMC cutoff date (which is 60 days before the project's LFD date) must be incorporated into the new FIS Report and FIRM. LOMRs that are issued after this time must be re-issued after the revised FIRM date.
170	8/17/2007	Existing standard. Already implemented.	Coastal Barrier Resources System	Program Standard	CBRS units shown on all new and revised FIRMs must be provided by the U.S. Fish and Wildlife Service.
172	10/1/2011	Existing standard. Already implemented.	Prelim Distribution	Working Standard	All Preliminary Title Blocks shall be **stamped "Preliminary" or "Revised Preliminary" as appropriate.**
173	10/1/2011	Existing standard. Already implemented.	Prelim Distribution	Working Standard	No effective date or map revised date shall be shown on the preliminary or revised preliminary title blocks.

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174	7/31/2013	For all ongoing and newly initiated projects.	Data Capture	Program Standard	Certification of completeness of all submitted data for FEMA-funded Flood Risk Projects must be provided when work on a project is complete. (via the certification forms provided in http://www.fema.gov/library/viewRecord.do?id=7577)
175	1/1/2013	Existing standard. Already implemented.	Data Capture	Working Standard	The preliminary FIS Report must be submitted with the other required submittals at the completion of the Floodplain Mapping task.
176	1/1/2013	Existing standard. Already implemented.	Data Capture	Working Standard	All spatial data must be georeferenced, have a standard coordinate system and projection defined and documented, and specify the horizontal and vertical datums used.
178	1/1/2013	Existing standard. Already implemented.	Data Capture	Working Standard	For each data development task prior to Develop [D]FIRM Database, the data for flooding sources receiving new or revised flood hazard analyses must be submitted in accordance with the FIRM Database Submittal Table, and following the schema of the FIRM Database Technical Reference. Non-FEMA funded external data studies are excluded from this requirement. Data submittals for all new, revised, and existing analyses must include the S_Submittal_Info table compliant with the schema in the FIRM Database Technical Reference.
180	11/30/2014	Existing standard. Already implemented.	Data Capture	Working Standard	All regulatory and non-regulatory deliverables and relevant supporting data must be submitted in one of the acceptable file format(s) and in the directory structure outlined in the Data Capture Technical Reference. If data are collected that are not specifically mentioned in the Data Capture Technical Reference but are relevant to the project, or data is obtained from existing flood hazard analyses, those data must be submitted, but do not have to follow the file format and directory structure requirements.

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181	11/30/2014	Existing standard. Already implemented.	Data Capture	Working Standard	A metadata file in XML format must be submitted that complies with the Metadata Profiles Technical Reference for each applicable task for regulatory and non-regulatory deliverables or relevant supporting data submittals.
182	1/1/2013	Existing standard. Already implemented.	Data Capture	Working Standard	Copies of all project-related data must be retained for a period of three years.
183	1/1/2013	Existing standard. Already implemented.	Data Capture	Working Standard	A file that compiles general correspondence must be submitted for each project task.
184	1/1/2013	Existing standard. Already implemented.	Data Capture	Working Standard	Any supporting data that are tiled must have an accompanying index spatial file. Tiles must be topologically correct and have only one part, and cannot self-intersect (must be simple). Adjacent tiles must not overlap or have gaps between them.
185	1/1/2013	Existing standard. Already implemented.	Data Capture	Working Standard	PDF files must be created using the source file (e.g., MS Word file). Created PDF files must allow text to be copied and pasted to another document.
186	1/1/2013	Existing standard. Already implemented.	Data Capture	Working Standard	A narrative must be submitted that summarizes the work performed (streams analyzed, type of Flood Risk Project, etc.), direction from FEMA, assumptions and issues, and any information that may be useful for the other mapping partners working on the project or subsequent users of the Flood Risk Project backup data for each task.

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187	1/1/2013	Existing standard. Already implemented.	Data Capture	Program Standard	All relevant data must be submitted that fully documents the flood risk project including the engineering analyses, input and output files for the models used; a report that documents the methodology, assumptions, and data used in the engineering analyses; applicable draft FIS Report text sections, tables, graphics, Flood Profiles; quality records in the form of (at a minimum) QR3 Self-Certification Forms, and QR3, QR5, QR7, & QR8 Checklists; input and output files associated with the flood risk assessments; the Flood Risk Report; the Flood Risk Map; the MXD(s) for the Flood Risk Map; and any other backup data. These data comprise the TSDN.
188	4/1/2003	Existing standard. Already implemented.	Base Map	Working Standard	FEMA must be able to distribute the base map data and floodplain information freely to the public in hardcopy and digital formats.
189	4/1/2003	Existing standard. Already implemented.	CNMS	Working Standard	Effective and revised flood hazard data must be tied in with no discontinuities. Where discontinuities cannot be resolved, they must be documented in the CNMS database, but not until the discontinuity is accepted by the FEMA Project Officer.
190	4/1/2003	Existing standard. Already implemented.	Quality Management	Program Standard	All technical review comments associated with the FIS Report, FIRM, or FIRM database must be fully addressed and resolutions must be fully documented.
191	4/1/2003	Existing standard. Already implemented.	Correspondence	Working Standard	All standard correspondence, letters, and enclosures distributed during the life of a Flood Risk Project must be prepared in accordance with the templates located at http://www.fema.gov/library/viewRecord.do?id=7577.
192	5/13/2002	Existing standard. Already implemented.	Project Initiation	Working Standard	Unique FEMA Case Numbers (e.g., 01-05-1234R) shall be assigned for all initiated LOMCs and Flood Risk Projects.
193	3/5/2007	Existing standard. Already implemented.	Post-Preliminary Deliverables	Program Standard	The Flood Hazard Determinations-on-the-Web tool is the authoritative source for creating and publishing Flood Hazard Determination Notices for Flood Risk Projects and LOMRs that result in new or modified flood hazard information.

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195	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Working Standard	LOMC requestors shall submit requests, including the required review and processing fee if applicable, to the appropriate processing address. The address is provided in the application forms package that must be used in preparing a LOMC request for submittal.
196	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Program Standard	If required by state law, State concurrence with the LOMR or CLOMR shall be required.
197	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Working Standard	Upon receipt of a LOMC, the following shall be done: • Make an initial determination as to the expected processing procedure • Assign a case number • Create a case file • Enter the request into the MIP • Record the date of receipt
198	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Working Standard	When processing a LOMC, any ongoing, past, or future map actions affecting the case shall be taken into consideration.
199	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Program Standard	LOMC submittals must include certifications by a licensed professional authorized to certify the data under state law.
200	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	A LOMR or CLOMR must be supported by a topographic map or digital data that includes all relevant information required by FEMA.
201	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	A LOMR or CLOMR must include proposed floodplain and/or floodway boundary delineations shown on an annotated FIRM.
202	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	All LOMRs including new grading or structures must include certified as-built construction plans, grading plans, or survey data.

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203	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	If the discharges in the effective FIS Report are not used in the LOMR or CLOMR submittal, the revision requester shall provide sufficient data to support the use of the new discharges for the 1-percent-annual-chance flood and other published flood frequencies.
204	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	A LOMR or CLOMR in riverine areas must submit a model duplicating the effective hydraulic model (multiple profile and floodway if appropriate). The revision requester shall use it to establish the baseline condition unless an existing conditions hydraulic model is required.
205	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	For a LOMR or CLOMR, an existing conditions hydraulic model is required if the duplicate effective model does not reflect the floodplain conditions prior to the start of the project.
206	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	If the revision is submitted as the result of a project, a post-project revised hydraulic model reflecting as-built conditions must be submitted.
207	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	At a minimum, the analyses and other supporting data provided in support of a revision request must be equivalent to or better than the scientific and technical data employed by FEMA for the preparation of the effective analyses.
210	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Working Standard	For floodplain boundary revisions based on new or more detailed topographic information, the revision requester will not be required to submit revised hydraulic analyses unless the changes in ground contours have significantly affected the geometry of cross sections used for the effective FIS Report and FIRM or have altered effective-flow areas.
213	4/1/2003	Existing standard. Already implemented.	Notice-to-User	Program Standard	During the Notice-to User revision process, approval of the action taken shall be obtained from the FEMA HQ due process lead and the decision must be documented in writing.

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214	4/1/2003	Existing standard. Already implemented.	Notice-to-User	Program Standard	During the Notice-to User revision process: • the FIRM database must be corrected as appropriate • the FIS Report, FIRM, and/or FBFM must be corrected and indicate on the document the reprinted date; • the corrected components must be distributed to all entities that received the defective product; and • the corrected components must be updated on the MSC site.
215	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Program Standard	Conditional LOMCs are subject to the same standards of a LOMA, LOMR-F, or LOMR except: • Because Conditional LOMCs are based on proposed construction, as-built information is not required. • The Conditional Comment Documents that are issued by FEMA do not amend the effective FHBM or FIRM. • Conditional LOMRs and CLOMR-Fs must demonstrate compliance with the Endangered Species Act.
216	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Working Standard	A letter shall be mailed to the requester acknowledging receipt of the LOMC request within business three days of receiving the data.
217	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Program Standard	If all information is not received within 90-days from the date of the request for additional data, the processing of the LOMC shall be suspended.
218	7/31/2015	Effective immediately	Letter of Map Change (LOMC)	Program Standard	LOMA, CLOMA, LOMR-F, CLOMR-F, LOMR and CLOMR determinations must be issued based on the effective FIRM and FIS for a community and may not be issued based on preliminary data for a FEMA-contracted Flood Risk Project or community-initiated map revision. Except, a one percent water surface elevation may be calculated during an LOMA, CLOMA, LOMR-F, or CLOMR-F review using data from these sources if the effective SFHA does not have BFEs or flood depths established and the preliminary data is the best available.

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219	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Working Standard	Following the preparation of the LOMC determination document, the LOMC shall be included in the list of determinations that is to be sent to FEMA for official approval. Following approval, the requester shall be provided with FEMA's final determination. A copy of the LOMC determination document shall also be sent to the community CEO and floodplain administrator and to the requester when applicable.
220	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Program Standard	The reviews of LOMC requests shall be processed in accordance with Parts 65, 67, 70, and 72 of the NFIP regulations.
222	7/31/2013	Applicable to all ongoing and future Flood Risk Projects.	Letter of Map Revision (LOMR)	Working Standard	When processing a LOMR for a FIRM that has been modernized (i.e., has a FIRM database), the map (FIRM and/or FBFM panels), Flood Profile, and data tables (i.e., Floodway Data and Summary of Discharges) enclosures shall be prepared in accordance with the FIRM Panel Technical Reference and the FIS Report Technical Reference. If the FIRM that is having a LOMR issued for it has not been modernized, either the current standards may be used (as indicated in the FIRM panel and FIS Report Technical References), or the standards in effect when the effective map and attachments were created.
223	7/31/2013	Implemented for LOMCs processed after the effective date.	Letter of Map Revision (LOMR)	Working Standard	If a LOMR changes stillwater elevations, transect data, flood elevations, discharges, and/or floodway information, the supporting information in the FIS Report and FIRM Database shall be revised as necessary.
224	4/1/2003	Existing standard. Already implemented.	Special Conversions	Working Standard	For all Special Conversions, coordination and documentation activities shall be performed to convert the community to the Regular Phase of the NFIP.
225	4/1/2003	Existing standard. Already implemented.	Special Conversions	Working Standard	FEMA management system databases shall be maintained for Special Conversions.

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226	7/16/2004	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Working Standard	LOMC requests involving below-grade crawlspaces constructed within the SFHA shall follow guidance provided in FEMA Technical Bulletin 11-01.
227	1/1/2013	Existing standard. Already implemented.	Notice-to-User	Program Standard	The Notice-to-Users revision only shall be used to correct errors or omissions in the FIS Report, FIRM Database, or on the FIRM that do not affect due process. A Notice-to-Users revision shall not change the effective date.
228	11/1/2009	Existing standard. Already implemented.	Stakeholder Engagement	Working Standard	All regulatory floodway changes must be coordinated with affected community officials and other stakeholders as early as possible.
229	7/31/2015	Effective immediately	Flood Profiles	Working Standard	Profiles shall be plotted as the projection of the stream invert and the flood surface(s) onto the flow path. The plots should show the locations of and clearly label: • Each lettered mapped cross section; • Splits and diversions; • Confluences with tributaries splits, and diversions; • Each stream crossing with symbology depicting the top of road and low chord elevations of modeled bridges and culverts along with the name of the bridge/culvert (e.g., Pine Street); • Extents of modeled hydraulic structures adjacent to the flooding source; • Upstream and downstream study limits of the flooding source; • Extent of backwater or flooding controlling the receiving stream and depiction of the backwater elevation along the Profile.
230	12/8/2011	Existing standard. Already implemented.	FIS/FIRM	Working Standard	The FIRM panels must be derived directly from the FIRM database and must be in agreement with the information shown in the FIS Report.

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232	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	Unless it can be demonstrated that the vertical and horizontal scale of the effective Flood Profiles are inadequate, re-analyzed streams must be produced using the same horizontal and vertical scales that were used in the effective Flood Profiles.
234	4/1/2003	Existing standard. Already implemented.	FIS Report	Working Standard	FIS Reports exceeding 150 pages in length shall be subdivided into two or more volumes.
235	4/1/2003	Existing standard. Already implemented.	FIS Report	Working Standard	If an FIS Report is published in 2 or more volumes, no volume shall exceed 100 pages.
236	4/1/2003	Existing standard. Already implemented.	FIS Report	Working Standard	For multi-volume FIS Reports, a single Table of Contents shall be produced for the entire report, and shall be included in all volumes.
237	4/1/2003	Existing standard. Already implemented.	FIS Report	Working Standard	Preliminary FIS Reports must include a stamp on the cover to indicate the Preliminary status and the date of the Preliminary issuance.
238	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	As outlined in the FIS Report Technical Reference, all numbered sections, tables and figures are required for every FIS Report prepared in compliance with the FIS Report Technical Reference, regardless of whether the topic addressed by that element is applicable to the Flood Risk Project.
239	12/8/2011	Existing standard. Already implemented.	FIS/FIRM	Working Standard	Table columns and names in the FIS Report must comply with the most current FIS Report Technical Reference unless FEMA Regional approval has been given to retain the prior FIS Report format.
240	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	When revising the FIS Report in compliance with the current FIS Report Technical Reference (as opposed to appending information to the former FIS report format), the FIS Report template at http://www.fema.gov/library/viewRecord.do?id=7577 must be used.

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241	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	References used within the FIS Report text must match the citation listed in the Bibliography and References table.
242	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	FIS Reports created in compliance with the FIS Report Technical Reference must use an "(Author Year)" format for inline citations.
243	12/8/2011	Existing standard. Already implemented.	FIS/FIRM	Working Standard	If a future conditions analysis is incorporated into the Flood Risk Project, the results shall be included in the FIRM database, FIRM, and FIS Report.
245	12/8/2011	Existing standard. Already implemented.	FIS Tables	Working Standard	The "Listing of NFIP Jurisdictions" and "Community Map History" tables in the FIS Report shall include all communities that fall within the county or jurisdiction whose FIS Report is being produced.
246	12/8/2011	Existing standard. Already implemented.	FIS Tables	Working Standard	Communities that have no Special Flood Hazard Areas identified shall be noted in the "Listing of NFIP Jurisdictions" and "Community Map History" FIS Report tables with a footnote.
247	12/8/2011	Existing standard. Already implemented.	FIS Tables	Working Standard	For FIS Reports produced in compliance with the FIS Report Technical Reference, all accredited levees, PALs, and non-accredited levees must be included in the "Levees" table of the FIS Report.
248	12/8/2011	Existing standard. Already implemented.	FIS Tables	Working Standard	All lettered or numbered cross sections must be shown on the Flood Profiles and, if a floodway was computed, must also be shown in the Floodway Data Table. Unlettered cross sections shown on the FIRM are not to be included on the Floodway Data Table or Flood Profiles.
249	12/8/2011	Existing standard. Already implemented.	FIS Tables	Working Standard	In the "Community Map History" table for FIS Reports produced in compliance with the FIS Report Technical Reference, the "FIRM Revisions Date(s)" column shall include all FHBM and FIRM revisions, and must be updated during each revision to reflect the new PMR effective date. All PMR effective dates must be included for the communities that received updated FIRM panels, even if the PMR did not revise all the panels within that community.

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250	12/8/2011	Existing standard. Already implemented.	FIRM Index	Working Standard	The FIRM Index shall be included in the FIS Report at a size of 11" x 17" for FIS Reports produced in compliance with the FIS Report Technical Reference.
251	12/8/2011	Existing standard. Already implemented.	FIRM Index	Working Standard	For FIRM Indexes which require more than 1 page, the page number shall be indicated in the title block in the following manner: FLOOD INSURANCE RATE MAP INDEX (Sheet 1 of 2). A county locator map shall be added with a rectangle showing the extent of the current FIRM Index sheet.
252	12/8/2011	Existing standard. Already implemented.	FIRM Index	Working Standard	For FIRM Indexes produced in compliance with the FIS Report Technical Reference, base map features that must be shown and labeled on the FIRM Index are HUC-8 watersheds and political jurisdictions. Community labels must also include the CID.
253	12/8/2011	Existing standard. Already implemented.	FIRM Index	Working Standard	For FIRM Indexes produced in compliance with the current FIS Report Technical Reference, FIRM panels shown on the FIRM Index shall be labeled only with the four-digit panel number and suffix. The effective date must also be included and shall be placed directly beneath the FIRM panel number in "mm/dd/yyyy" format.
254	12/8/2011	Existing standard. Already implemented.	FIRM Index	Working Standard	The FIRM Index shall identify unprinted panels with asterisks and footnotes that define the reason(s) for the panel(s) not being printed.
255	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	For FIS Reports produced in compliance with the FIS Report Technical Reference, every note that is shown on the Notes to Users on one or more FIRM panels must be included once in the Notes to Users section in the FIS Report.
256	12/8/2011	Existing standard. Already implemented.	Flood Profiles	Working Standard	Flood Profiles for Zone AE must show data for each of the 5 standard (10%-, 4%-, 2%-, 1%-, and 0.2%-annual-chance) flood events if they were calculated as part of the Flood Risk Project.

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257	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	The FIS Report deliverable to the MSC must be an unsecured PDF file, with as much searchable text as possible, and must be bookmarked in accordance with the direction outlined in the FIS Report Technical Reference. Embedded graphics, where necessary, must have a resolution of 400 dpi.
259	4/1/2003	Existing standard. Already implemented.	FIS Report	Working Standard	A description of all dams and other non-levee flood protection measures affecting the communities represented in the project area shall be included in the FIS Report.
260	4/1/2003	Existing standard. Already implemented.	FIS Report	Working Standard	A description of any unusual floodway procedures that deviate from national policy, such as State-imposed or locally imposed surcharge limits of less than 1.0 foot for regulatory floodway, must be listed in the "Floodways" section of the FIS Report.
261	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	Counties that have an effective countywide FIS Report must remain countywide, regardless of whether they are updated to comply with the FIS Report Technical Reference or not.
264	4/1/2003	Existing standard. Already implemented.	FIS Tables	Working Standard	For cross-sections shown in areas of backwater flooding, elevations in the "Without Floodway" column of the Floodway Data Table shall not include backwater effects. The "Without Floodway" values must include a footnote stating, "Elevation Computed Without Consideration of Backwater Effects From (Source of Flooding)". The words "Backwater Effects" are to be replaced with "Tidal Effects," "Overflow Effects," "Ice Jam Effects," or "Storm Surge Effects,", as needed, to reference the appropriate flooding situation.
265	4/1/2003	Existing standard. Already implemented.	FIS Tables	Working Standard	When a part of a regulatory floodway lies outside the jurisdiction, both the total floodway width, and the width within the jurisdiction, shall be listed in the FIRM database and Floodway Data Table.
267	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	Only one stream shall be shown on any given Flood Profile panel.

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268	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	All communities whose FIS Report is being updated to comply with the FIS Report Technical Reference must receive a copy of the new FIS Report, regardless of whether they are affected by the new Flood Risk Project or are outside the project area.
270	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	On the Flood Profiles for tributary streams, the 1-percent-annual-chance flood backwater from the main watercourse or water body shall be labeled as "Backwater From (Main Stream Name)."
272	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	A vertical elevation scale of 1 inch equals 1, 2, 5, 10, or 20 feet is to be used for the Flood Profiles. Elevations shall be shown on the left side of the grid at 1-inch intervals within the profile elevation range.
273	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	The 1%-annual-chance Flood Profile plots shall agree with the distances and elevations shown in the Floodway Data Table, with a maximum tolerance of 1/20 inch on the printed Flood Profile panel. Other features shown on the Profiles, such as cross-section labels and hydraulic structures, shall also be accurately plotted to within the 1/20 inch tolerance.
274	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	The horizontal and vertical scales of the Flood Profiles shall be chosen so that Flood Profile slopes are reasonable and can be easily interpreted by the user.
275	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	The horizontal scale of the Flood Profile shall be labeled at 1-inch intervals along the bottom edge of the grid and legend box.
277	12/8/2011	Existing standard. Already implemented.	FIS Report	Working Standard	For FIS Reports prepared in compliance with the FIS Report Technical Reference, any information that was included in Section 10 of a previous FIS Report using an approach known as "Revisions by Addendum" shall be incorporated into the relevant sections and tables of the current FIS Report.
278	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	River stationing is to be referenced from a physical location such as a confluence or structure.

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279	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	Downstream flood elevations are to begin on the left edge of the Flood Profile.
280	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	Stream distances reported in the Floodway Data Tables, Profiles, and FIRM database must be measured along the profile baseline.
281	4/1/2003	Existing standard. Already implemented.	Flood Profiles	Working Standard	Distance and elevation units used on a Flood Profile must be consistent with the units used in the Floodway Data Table.
282	1/1/2013	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	All FIRM panel symbology and labels must be clear and readable and clearly communicate the flood hazard information needed for insurance and mitigation purposes.
283	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	The FIRM panel "Notes to Users" section must contain notes referring the user to the FIS Report for a detailed legend and FIRM Index, to the MSC website for other digital products providing the NFIP contact information, and to the base map data source.
284	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	The LiMWA note in the FIRM panel "Notes to Users" section shall include a legend.
285	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	All elements of the FIRM title block must be present and must adhere to the specifications in the FIRM Panel Technical Reference.
286	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	The jurisdiction names in the FIRM panel title block must include, at a minimum, the jurisdiction prefix (e.g., city, town, or village), jurisdiction name, and full State name. FIRM panels for individual jurisdictions shall also include the name of the county, except for jurisdictions that are officially classified as "Independent."

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287	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	When each new edition of a FIRM panel is prepared, the suffix for each revised FIRM panel shall be changed to the next alphabetical letter while skipping the letters "I" and "O". For first time countywide or partial countywide FIRMs, the map suffix should be one letter higher than the highest suffix of all jurisdictions included.
288	4/18/2002	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	FIRM panels, FIRM Indexes, and FIS Reports shall follow the ID numbering schemes outlined in the FIRM Panel and FIS Report Technical References.
289	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	The FIRM panel map collar must include a North Arrow, Scale Bar, and map projection and datum information.
290	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	First-time modernized FIRM panels must be in countywide format unless the FIRM is for a multi-county jurisdiction that will retain its community-based FIRM format.
291	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Program Standard	A determination to use Partial-Countywide FIRM panel and FIRM Database format must be coordinated with and approved by the FEMA Region and FEMA Headquarters.
292	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	If partial countywide FIRM panel mapping is pursued, the FIRM title block will list all of the jurisdictions on the FIRM panel, but the ones not included in the partial countywide mapping will be noted as having their FIRMs and FIS Reports published separately.
294	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	For partial countywide FIRM panel mapping, panel numbers must be assigned for the entire county, just as for a full countywide panel layout. Numbering of countywide FIRM panels must consider the numbering of the existing panels so as not to create two panels with the same number (e.g. 0250). If there would be two panels with the same number, start countywide numbering by going up to the first even thousand above the highest existing FIRM panel number.

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295	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	When partial countywide mapping is processed, any existing community-based FIRM panels that overlap the partial countywide must be reissued with the overlapping area blanked out and the blanked out area must include a note referring the users to the partial countywide FIRM.
296	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	If a FIRM revision is being processed when there is a separate FBFM, the two maps should be combined into the new format FIRM using the new flood zone designations and the FBFM shall no longer exist as a separate map.
297	1/1/2013	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	On FIRM panels, symbolization and labeling of all base map, hydraulic, and flood theme features must be standardized as shown in the FIRM Panel Technical Reference.
300	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	All FIRM panels shall be printed to full page, portrait orientation, ARCH D map frames **with a trimmed paper size of: Height 36" x Width 24. The title** block must appear in the bottom right corner and be 5.3 inches wide by 9 inches in height.
301	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	FIRM panels must include a white border on all sides and must contain a title block on the bottom right corner, a legend, a Notes to Users section, and a Panel Locator section across the bottom of the panel, as outlined in the FIRM Panel Technical Reference.
304	10/1/2011	Existing standard. Already implemented.	Base Map	Working Standard	All raster base maps used for FIRM panel preparation must be georeferenced and orthorectified.
305	10/1/2011	Existing standard. Already implemented.	Map Format and Layout	Working Standard	A countywide FIRM must provide seamless spatial base map and flood hazard coverage within the county area for all jurisdictions shown on the FIRM.
306	10/1/2011	Existing standard. Already implemented.	Floodplain Boundaries	Working Standard	Any existing mismatches in floodplains and flood hazard information between communities and counties must be resolved as part of a FIS Report/FIRM update.

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307	10/1/2011	Existing standard. Already implemented.	Base Map	Working Standard	Raster base map image(s) used for FIRM panel preparation shall cover the entire jurisdiction being analyzed except in the cases of open water areas and/or areas that may be restricted due to security concerns.
308	10/1/2011	Existing standard. Already implemented.	Base Map	Working Standard	The FIRM base map is the horizontal reference data shown on the FIRM to assist in interpreting the areas impacted by the flood risk information shown. The term base map does not include topographic or elevation data. The following types of base map features must be depicted on the FIRM panel if they occur within the community: • **transportation features, including roads and railroads, hydrographic features,** hydraulic structures • **boundaries that identify county and State boundaries, corporate limits,** ETJ areas, military lands, and tribal lands, and • **U.S. PLSS features.**
309	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Any transportation feature shown and labeled on a Flood Profile shall be labeled on the FIRM panel.
310	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Primary roads, as defined by the MAF/TIGER data, shall be shown and labeled on the FIRM panel.
311	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	On FIRM panels, all hydrographic features (streams, lakes, ponds, bays, and oceans) that have an identified flood hazard associated with them shall be labeled.

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312	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Profile Baseline	Working Standard	A profile baseline must be shown on FIRM panels for all flooding sources with profiles or otherwise established riverine BFEs (static elevations excluded), and for modeled riverine Zone A areas.
313	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	In areas of riverine flooding where no profile baseline is available but a flood hazard has been identified, the bank or centerline representation of the hydrographic feature must be shown on vector-based FIRM panels.
314	10/1/2011	Existing standard. Already implemented.	Profile Baseline	Working Standard	Hydrographic feature lines represented on FIRM panels must not obscure the Profile Baseline symbology.
315	10/1/2011	Existing standard. Already implemented.	Levee	Working Standard	All levees stored in the FIRM Database shall be labeled and symbolized on the FIRM panel as outlined in the FIRM Panel Technical Reference, with the appropriate accreditation status noted.
316	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Hydraulic structures other than levees shall be labeled on the FIRM panel only if shown on the Flood Profile of the FIS Report. The label name must match what is shown on the Flood Profile. If 1%, 0.2%-annual-chance-flood discharge, and/or floodway are contained in the structure, a note must be placed on the FIRM panel near the feature to refer to the highest contained discharge.
317	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	All political entities (including Extra-Territorial Jurisdictions) shall be depicted and labeled on the FIRM panel with the appropriate jurisdiction names and CIDs or area designator.
319	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Any area shown on the FIRM panel as an Area Not Included shall be labeled with the entity's name and the notation "Area Not Included".
320	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Vector base map features are not required on the FIRM in Areas Not Included.

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322	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	On FIRM panels, when boundaries of different types are coincident with each other or with base map features, only the highest priority feature shall be shown.
323	10/1/2011	Existing standard. Already implemented.	Projections and Coordinate Systems	Working Standard	FIRM panels must show horizontal reference grids and corner coordinates selected, displayed and labeled as directed in the FIRM Panel Technical Reference.
332	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	If a printed FIRM panel falls within the area of a smaller-scale panel that is also printed, the smaller-scale panel shall show a breakout note in the blank area represented by the larger-scale panel (the breakout panel area). This note is placed in the center of the breakout panel area and specifies the larger-scale **panel's map number and scale. The suffixes shall not be used in breakout** panel notes (to avoid unnecessary updates in PMRs).
334	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Each flood hazard zone shall be bounded by a SFHA/FLOOD ZONE BOUNDARY line type when adjacent to another flood hazard area of a different type or elevation.
335	10/1/2011	Existing standard. Already implemented.	Floodway	Working Standard	Regulatory floodways shall be shown on the FIRM panel within the SFHA and, at lettered or numbered cross-section locations, floodway widths must agree with the values shown on the FDT in the FIS Report and the FIRM Database tables, within a maximum tolerance of 5 percent of the map scale or 5 percent of the distance, whichever is greater.
338	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Special Flood Hazard Areas shall be labeled at least once with the flood zone on a FIRM panel and, if appropriate, with the static elevation, velocity, or depth.
339	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Zone X areas that represent future conditions or areas protected by accredited levees shall be labeled on the FIRM panel in accordance with the FIRM Panel Technical Reference.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
340	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	SFHAs with assigned static elevations, depths, or velocities shall have their static BFE, depth, or velocity value labeled on the FIRM panels in accordance with the FIRM Panel Technical Reference.
341	10/1/2011	Existing standard. Already implemented.	BFEs	Working Standard	All BFE lines stored in the FIRM Database must be shown on FIRM panels.
342	10/1/2011	Existing standard. Already implemented.	Cross-Sections	Working Standard	Cross sections stored in the FIRM Database must be shown on the FIRM panels if they are attributed as one of the following line types: LETTERED, MAPPED and NOT LETTERED, MAPPED.
343	10/1/2011	Existing standard. Already implemented.	Cross-Sections	Working Standard	On FIRM panels and in FIRM Databases, lettered or numbered cross sections for each stream analyzed by detailed methods shall be labeled alphabetically or numerically from downstream to upstream.
345	10/1/2011	Existing standard. Already implemented.	Cross-Sections	Working Standard	On FIRM panels, lettered or numbered cross sections shall be symbolized and labeled as outlined in the FIRM Panel Technical Reference.
346	10/1/2011	Existing standard. Already implemented.	Cross-Sections	Working Standard	On FIRM panels, all LETTERED, MAPPED and NOT LETTERED, MAPPED cross sections must be labeled with the regulatory WSEL value, rounded to the nearest tenth of a foot. All lettered or numbered cross section WSEL values must match the FDT in the FIS Report.
347	10/1/2011	Existing standard. Already implemented.	Cross-Sections	Working Standard	If unlettered cross sections and BFEs cannot be shown on the FIRM panel because of crowding due to steep terrain, a note shall be placed referring the user to the Flood Profiles in the FIS Report.
348	10/1/2011	Existing standard. Already implemented.	Cross-Sections	Working Standard	In the event that a cross section contains multiple water surface elevations the cross section shall be segmented and each segment labeled on the FIRM panel with its corresponding WSEL value and a hexagon.
349	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	On the FIRM panels and in the FIRM Database, LIMIT LINES shall be placed at the beginning and at the end of flow in every area analyzed by detailed methods and shall be depicted as specified in the FIRM Panel Technical Reference.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
351	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	If transect lines are shown in the FIRM database they must be delineated and labeled on the FIRM panels.
352	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	The LiMWA must be included in the FIRM Database if it has been calculated as part of a coastal Flood Risk Project, and shall normally be shown on FIRM panels. All community requests to have the LiMWA removed from the FIRM must be received at least 2 months prior to the issuance of the LFD.
356	10/1/2011	Existing standard. Already implemented.	Coastal Barrier Resources System	Working Standard	All FIRM panel notes, labels, and symbolization associated with CBRS and Otherwise Protected Areas shall conform to the specifications outlined in the FIRM Panel Technical Reference.
357	10/1/2011	Existing standard. Already implemented.	FIRM Graphic Standards	Working Standard	Each FIRM panel must have a map legend that includes all the required elements and complies with the symbology as outlined in the FIRM Panel Technical Reference.
359	10/1/2011	Existing standard. Already implemented.	FIRM Database	Working Standard	Data sources in the FIRM Database must be documented with Source Citations in the database and the metadata.
361	10/1/2011	Existing standard. Already implemented.	FIRM Database	Working Standard	The FIRM Database digital data must be submitted in a series of layers that cover the entire geographic area being mapped and not in individual small tiles that cover limited geographic areas.
363	10/1/2011	Existing standard. Already implemented.	National Flood Hazard Layer (NFHL)	Working Standard	The NFHL must be used as the source for effective digital FIRM Database data when starting FIRM updates, and used for mandatory edge matching at county/community boundaries.
364	10/1/2011	Existing standard. Already implemented.	FIRM Database	Working Standard	The FIRM Database must not contain duplicate spatial features.
365	10/1/2011	Existing standard. Already implemented.	FIRM Database	Working Standard	All included tables of the FIRM Database shall be documented in the metadata in accordance with the Metadata Profiles Technical Reference, and the software release of the personal geodatabase submitted shall also be documented.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
366	10/1/2011	Existing standard. Already implemented.	Projections and Coordinate Systems	Working Standard	FIRM Database tables must comply with the following database schema properties defined in the FIRM Database Technical Reference: • Tables and Feature Classes • Spatial Reference Systems • Topology Rules • Domains
367	10/1/2011	Existing standard. Already implemented.	FIRM Database	Working Standard	In the FIRM Database, all final revised FIRM panels shall get new FIRM panel Map Number suffixes and effective dates in the S_FIRM_Pan feature class.
368	10/1/2011	Existing standard. Already implemented.	LOMR Incorporation	Program Standard	All LOMRs that are located within the PMR panel footprint and are effective prior to the LOMC cutoff date (which is 60 days before the project's LFD date) must be incorporated into the FIRM Database.
369	10/1/2011	Existing standard. Already implemented.	FIRM Database	Working Standard	Floodplain boundary lines in the FIRM Database must be generalized to no more than an average of one vertex every 10 feet while still meeting FBS standards.
370	10/1/2011	Existing standard. Already implemented.	FIRM Database	Working Standard	FIRM Database Flood Theme and Base Map features shall not have disconnects, jogs, or missing features during edge matching and at community boundaries.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
371	11/30/2014	Existing standard. Already implemented.	Data Capture	Working Standard	The following Regulatory deliverables must be submitted using the file formats and directory structure specified in the Data Capture Technical Reference. • **Transmittal Form** • **FIRM Database** • **Orthophotos (if applicable)** • **FIRM Scans** • **World Files** • **FIS Report** • **Transmittal to Community CEO** • **Community Map Action List** • **Inventory Worksheet** for Each Community
372	10/1/2011	Existing standard. Already implemented.	FIRM Database	Working Standard	Coincident features must share the same geometry, vertex for vertex, within the FIRM database files.
373	1/1/2013	Existing standard. Already implemented.	FIRM Database	Program Standard	The FIRM Database must be submitted using the schema found in the FIRM Database Technical Reference.
374	11/30/2014	Existing standard. Already implemented.	BFEs	Working Standard	BFEs (i.e., cross-section values supplemented with BFE lines where needed) must be shown at appropriate locations to allow map users to accurately interpolate flood elevations both horizontally and vertically.
375	10/1/2011	Existing standard. Already implemented.	Levee	Working Standard	The S_Levee table is required for any Preliminary or Final FIRM Database that includes levees, floodwalls, closure structures, berms, embankments, or dikes that have been designed for flood control, whether or not they have been demonstrated to meet the NFIP requirements in 44 CFR 65.10.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
377	7/31/2013	Implemented for all projects where the FIRM Database has not yet been submitted to the NFHL	National Flood Hazard Layer (NFHL)	Working Standard	For PMRs, once the NFHL for a community is converted to the latest FIRM Database schema, all database submissions will also be required to conform to this schema. For non-FEMA funded external data studies and for portions of a study where the engineering is unrevised, attribute data associated with the schema that is not needed for FIRM production may be excluded from the study submittal with permission from the FEMA Regional Office. Each exclusion should be documented in the FIRM Database metadata file that accompanies the FIRM Database.
378	7/31/2013	Implemented for any project not yet at preliminary.	PMR	Working Standard	For PMRs where updated political boundaries are available for the entire extent of the FIRM database, the S_Pol_AR feature class shall be incorporated into the RFHL and shown on the FIRM Index.
379	6/1/2012	Existing standard. Already implemented.	National Flood Hazard Layer (NFHL)	Working Standard	For PMRs, the revised FIRM database layers within the PMR panel footprint shall be incorporated into the RFHL. Certain layers such as watershed boundaries, nodes, and political areas may extend outside of the PMR footprint.
383	4/1/2003	Existing standard. Already implemented.	Coordination	Working Standard	After preliminary issuance of the FIS Report and FIRM, any major changes must be coordinated with the FEMA Regional office.
384	4/1/2003	Existing standard. Already implemented.	Correspondence	Working Standard	In the absence of a final CCO meeting a letter shall be sent to the community and interested stakeholders to document the decision to forego the meeting.
385	4/1/2003	Existing standard. Already implemented.	Fed Register	Program Standard	Per 44 CFR 67.4, the News Release and Federal Register Proposed Flood Hazard Determination Notice shall include all communities affected by new or modified flood hazard information. The newspaper notice shall be published twice within the 10-days of notification of the community CEO, after publication of the Federal Register Proposed Flood Hazard Determination Notice.
386	4/1/2003	Existing standard. Already implemented.	Fed Register	Program Standard	The community and other affected stakeholders must be notified when corrections to the News Release or Federal Register are required, including timelines for publishing corrections.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
387	5/30/2014	Implemented for all projects where the Federal Register Flood Hazard Determinations Notice has not yet been published.	Fed Register	Program Standard	The appropriate Federal Register Flood Hazard Determinations Notice proposing changes to flood hazard information shall be compiled for all communities affected by the addition or modification of flood hazards (i.e., the Proposed Notice for flood risk studies and the Interim Notice for LOMRs). The Notice shall include a hyperlink for the official FEMA website through which stakeholders can access the products depicting the proposed flood hazard changes. The Notice shall be submitted to the designated FEMA coordinator to route for concurrence and signature. FEMA shall coordinate with Office of Federal Register to ensure timely publication of the Notice in the Federal Register. The published Notice must be reviewed to ensure accuracy; if needed, corrections must be made, and other Project Team members must be notified of the correction.
388	12/1/2011	Existing standard. Already implemented.	Appeals	Program Standard	The statutory 90-day administrative appeal period cannot be extended; no appeals will be accepted after the 90-day appeal period.
389	12/1/2011	Existing standard. Already implemented.	Appeals	Program Standard	Written acknowledgement of all data submitted during the statutory appeal period shall be provided to the affected community.
390	12/1/2011	Existing standard. Already implemented.	Appeals	Working Standard	When performing new analyses and developing revised flooding information, appellants must tie the new BFEs, base flood depths, SFHA boundaries, SFHA zone designations, and/or regulatory floodway boundaries into those shown on the FIRM and in the FIS Report for areas not affected by the appeal.
391	1/1/2013	Existing standard. Already implemented.	Appeals	Program Standard	FEMA shall evaluate appeal submittals, and prior to LFD, FEMA or its designee must provide the community with a resolution letter and must provide a copy of the revised FIRM if changes were made as a result of the appeal.
392	11/1/2010	Existing standard. Already implemented.	Appeals	Program Standard	The Scientific Resolution Panel must be made available to communities that submit qualifying scientific and/or technical data during the 90-day administrative appeal period.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
393	1/1/2013	Existing standard. Already implemented.	Post-Preliminary Deliverables	Program Standard	A copy of the final FIRM must be delivered to affected communities 90 days before the effective date.
394	4/1/2003	Existing standard. Already implemented.	Post-Preliminary Deliverables	Working Standard	The Engineering Library shall be the official repository for all technical engineering data including any LOMCs, TSDN and related Flood Risk Project documentation. Information shall be archived and maintained in accordance with FEMA records management standards.
395	1/1/2013	Existing standard. Already implemented.	Post-Preliminary Deliverables	Working Standard	FEDD files must be submitted to FEMA for review 60 days before the LFD is scheduled to be issued.
396	1/1/2013	Existing standard. Already implemented.	Post-Preliminary Deliverables	Working Standard	During post-preliminary processing the FEDD and all associated correspondence must be compiled for each affected community in accordance with all relevant regulations. When more than one entity is responsible for post-preliminary activities, each entity must ensure the FEDD and all related documentation is complete at the time the responsibility is transferred to the next entity.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
397	1/1/2013	Existing standard. Already implemented.	Post-Preliminary Deliverables	Working Standard	The following data must be submitted at the end of each mapping project: • FBS Self-Certification Document (submitted within 30 days after issuance of preliminary maps); • QA report stating compliance with the FBS standard. • Revised Floodplain Boundary Standard Self-Certification Document (submitted within 30 days after issuance of the LFD if floodplain boundaries were revised during the post-preliminary phase); • Correspondence file including any documentation not previously submitted during earlier tasks or as part of the FEDD file related to coordination and processing decisions made during the course of the Flood Risk Project. • FEDD for each affected community • FEDD Checklist for each FEDD file • TSDN Checklist and Certification form
398	1/1/2013	Existing standard. Already implemented.	Post-Preliminary Deliverables	Working Standard	The FEDD files must be separate for each community.
400	6/1/2010	Existing standard. Already implemented.	Post-Preliminary Deliverables	Working Standard	Map Service Center deliverables must be uploaded through the MIP for all Flood Risk Projects.
401	4/1/2003	Existing standard. Already implemented.	LFD	Program Standard	The LFD date must be no sooner than 60 days after the end of the 90-day administrative appeal period or following resolution of all appeals, whichever is later.
402	4/1/2003	Existing standard. Already implemented.	LFD	Program Standard	The LFD package shall be submitted to FEMA HQ for review and approval prior to issuing LFDs to affected communities.
403	4/1/2003	Existing standard. Already implemented.	LFD	Program Standard	FEMA shall publish a final FHD notice in the Federal Register no later than three (3) months following issuance of the LFD.

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404	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Working Standard	The Compendium of Flood Map Changes shall be published every 6 months. Publication shall occur within 15 days of the close of the 6-month reporting period.
405	4/1/2003	Existing standard. Already implemented.	Revalidation	Program Standard	2-4 weeks before the effective date of the revised map, the revalidation package shall be submitted to FEMA for review and approval prior to issuing the revalidation letters.
406	4/1/2003	Existing standard. Already implemented.	Revalidation	Program Standard	The LOMC-VALID letter shall be provided to the community CEO and floodplain administrator and the LOMC Subscription Service Coordinator before the effective date of the revised FIRM(s).
407	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Program Standard	FEMA will widely distribute the following at regular intervals: • final LOMCs with attachments • final SOMAs • revalidation letters.
408	4/1/2003	Existing standard. Already implemented.	Letter of Map Change (LOMC)	Working Standard	Requests for Letters of Determination Review (LODRs) shall be processed.
409	4/1/2003	Existing standard. Already implemented.	Due Process	Program Standard	Suspension notification letters shall be distributed to communities that have not yet adopted NFIP compliant ordinances within 90 and 30 days prior to the FIRM effective date.
410	4/1/2003	Existing standard. Already implemented.	Correspondence	Working Standard	Over the life of a Flood Risk Project, NFIP eligibility shall be reviewed and related correspondence shall be prepared for newly-eligible communities.
411	1/1/2013	Existing standard. Already implemented.	Fed Register	Program Standard	FEMA will publish a notice of community eligibility in the Federal Register.
412	12/3/2008	Existing standard. Already implemented.	Coastal	Working Standard	For coastal Flood Risk Projects, the LiMWA must be calculated, where appropriate.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
413	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Working Standard	Locally-provided, -sourced, or -validated building footprint, location, and/or population data shall be the only acceptable data sources to be used to populate structure and population count attributes within the CSLF dataset.
414	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Working Standard	Flood risk datasets derived from new or updated data must reflect the regulatory elevations as shown on the preliminary FIRM, if applicable. If floodplain delineations are altered as a result of appeals or other changes during the post-preliminary process, the Changes Since Last FIRM dataset shall be updated to reflect those changes.
415	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Working Standard	Flood risk datasets derived from effective data must reflect the effective regulatory elevations as shown on the FIRM.
416	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Working Standard	Depth and Analysis Grids must share the same terrain and bathymetry source datasets as the engineering models.

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<table>
<tr><th>SID #</th><th>Effective Date</th><th>Implementation Description</th><th>Category</th><th>Standard Type</th><th>Standard</th></tr>
<tr><td>417</td><td>7/31/2013</td><td>Implemented with all new flood risk projects initiated in FY13.</td><td>Non-Regulatory Datasets</td><td>Program Standard</td><td>The minimum datasets associated with the Flood Risk Project are defined as follows:
<table>
<tr><th colspan="2">Non-Regulatory Product/Dataset</th><th>New Flood Hazard Analysis Conducted</th><th>No New Flood Hazard Analysis Conducted</th></tr>
<tr><td colspan="2">Flood Risk Database</td><td>Required</td><td>Required</td></tr>
<tr><td rowspan="6">Flood Risk Dataset</td><td>Changes Since Last FIRM (CSLF)</td><td>Required[1]</td><td>N/A</td></tr>
<tr><td>Water Surface Elevation Grids</td><td>Required[2]</td><td>N/A</td></tr>
<tr><td>Flood Depth Grids</td><td>Required[2]</td><td>N/A</td></tr>
<tr><td>Percent Annual Chance & Percent 30-year Chance Grids</td><td>Required[3]</td><td>N/A</td></tr>
<tr><td>Flood Risk Assessment</td><td>Required (AAL[4] and Refined[5])</td><td>Required (AAL[4])</td></tr>
<tr><td>Areas of Mitigation Interest (AoMI)</td><td>Required</td><td>Required</td></tr>
<tr><td colspan="2">Flood Risk Map</td><td>Required</td><td>Required</td></tr>
<tr><td colspan="2">Flood Risk Report</td><td>Required</td><td>Required</td></tr>
</table>
[1]CSLF is optional in areas where digital modernized floodplain boundaries are not available for the effective FIRM
[2]Riverine studies: 10%, 4%, 2%, 1%, "1%+", and 0.2% annual-chance floods;
Coastal studies: only the 1% annual chance flood;
Levee studies: Riverward/Seaward side - same as Riverine or Coastal
Landward side - only the scenario(s) used to delineate SFHA boundary
[3]Riverine only
[4]AAL data only from the FEMA 2010 AAL Study;
Both riverine and coastal areas will have 10%, 2%, 1%, 0.5%, and 0.2% annual-chance floods, and Annualized;
[5]Analysis can be conducted at census block or user-defined facility level.
Riverine studies: 10%, 4%, 2%, 1%, and 0.2% annual-chance floods, and Annualized;
Coastal studies: only the 1% annual chance flood;
Levee studies: Riverward/Seaward side - same as Riverine or Coastal
Landward side - only based on the landward depth grid</td></tr>
</table>

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
418	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Working Standard	Depth grids for open water shall reflect the depth of flooding above normal pool.
419	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Working Standard	The extent of water surface elevation change grids shall, at a minimum, reflect those areas that were both SFHA before and after the revision.
420	1/1/2013	Existing standard. Already implemented.	Flood Risk Report	Working Standard	The Flood Risk Report will only report on the extent of the flood risk data that lies within the Flood Risk Project area.
421	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Program Standard	To ensure privacy, sensitive claims data will be aggregated and/or generalized at the centroid of the census block and represented as a point.
423	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Program Standard	All fields in the Flood Risk Database Technical Reference must be populated unless marked as [E]nhanced.
424	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Working Standard	As an outcome of Discovery, a tiling structure must be defined for products.
425	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Working Standard	The National Flood Hazard Layer (or other comparable dataset with all effective FIRMs and LOMRs incorporated) shall be the source for the effective flood hazard area data for non-regulatory products.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
426	1/1/2013	Existing standard. Already implemented.	Flood Risk Report	Working Standard	Each Flood Risk Report shall include the following sections: i. Preface ii. Table of Contents 1. Introduction 2. Risk Analysis 3. Flood Risk Analysis Results 4. Actions to Mitigate Flood Risk 5. Acronyms and Definitions 6. Additional Resources 7. Data Used to Develop Flood Risk Products
427	1/1/2013	Existing standard. Already implemented.	Flood Risk Report	Working Standard	The Flood Risk Report must include the following tables: Project Specific Tables: • List of all the communities in the project area; • CSLF summary; • Risk Assessment summary; Community Specific Tables: • Community overview; • CSLF summary; • Risk Assessment summary; • AoMI summary

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
428	1/1/2013	Existing standard. Already implemented.	Flood Risk Map	Working Standard	The Flood Risk Map must illustrate flood risk in the project area, potential mitigation opportunities, and include the following elements: • Map body • Title block • Map legend • Project locator • North arrow • Map scale
429	11/30/2014	Existing standard. Already implemented.	Data Capture	Working Standard	The following Non-regulatory deliverables must be submitted using the file formats and directory structure specified in the Data Capture Technical Reference. * Flood Risk Database * Depth and Analysis Grids * Metadata file * Full text of the Flood Risk Report with bookmarks, a hyperlinked table of contents and section headings. * Flood Risk Map
431	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Working Standard	For Flood Risk Product SHP and DBF file formats, domain-based fields shall contain the actual descriptive values, not the numeric or alphanumeric coded value.
432	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Working Standard	Datasets in the FRD must be delivered in their entirety even if a portion of the dataset lies outside the define project footprint.
433	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Working Standard	Non-regulatory datasets must be delivered within the Flood Risk Database and must not be tiled or subdivided.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
438	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Working Standard	Hazus 2.1 shall be the source for Census block boundaries within the FRD.
440	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Working Standard	The Flood Risk Map must be derived directly from the Flood Risk Database. The Flood Risk Database must be in agreement with the information shown in the Flood Risk Report.
441	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Working Standard	Text in the FRR_Custom and FRR_Project tables must be stored as an Office Open XML 2.0 compliant markup fragment containing only text and styles.
442	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Program Standard	Non-regulatory flood risk datasets must comply with the following database schema properties defined in the Flood Risk Database Technical Reference: • Tables and Feature Classes • Raster Datasets • Spatial Reference Systems • Topology Rules • Relationship Classes • Domains
443	1/1/2013	Existing standard. Already implemented.	Flood Risk Database	Program Standard	In order to maintain privacy, the L_Claims table, if there are less than five (5) claims, five (5) repetitive loss claims, or five (5) severe repetitive loss claims in a community, then the relevant value field shall be set to null.
444	4/1/2003	Existing standard. Already implemented.	Levee	Program Standard	Levee systems can only be accredited in their entirety when compliance with 44 CFR Part 65.10 is demonstrated.
445	4/1/2009	Existing standard. Already implemented.	Levee	Program Standard	FEMA will not grant extensions to the 24-month PAL period.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
446	4/1/2009	Existing standard. Already implemented.	Levee	Program Standard	Levee accreditation must be based upon detailed H&H analyses.
447	4/1/2009	Existing standard. Already implemented.	Levee	Program Standard	If the levee system does not continue to meet the criteria within 44 CFR Section 65.10, FEMA shall initiate the levee de-accreditation process.
448	9/1/2006	Existing standard. Already implemented.	Levee	Program Standard	A levee system shall only be designated by FEMA as a PAL if the levee system is already accredited on the effective FIRM and, the owner of the levee system or the community is attempting to compile levee accreditation documentation to demonstrate continuation of compliance with 44 CFR 65.10. The opportunity for a PAL designation is only offered one time for any given system.
449	9/1/2006	Existing standard. Already implemented.	Levee	Program Standard	If a levee system qualifies for the PAL designation, the affected communities will be given an opportunity to sign a PAL agreement.
450	2/1/2009	Existing standard. Already implemented.	Levee	Program Standard	A structure shall only be considered a levee when it can be demonstrated that the structure was designed and has been operated and maintained as a levee. Structures that cannot meet these requirements cannot be considered for accreditation under 44 CFR 65.10.
452	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Floodway	Working Standard	Floodway boundaries shall be placed on the riverside of a levee unless the community specifically requests otherwise, or where hydraulic calculations demonstrate a floodway is warranted elsewhere.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
501	7/31/2013	Implemented for all projects once the NFHL for a community is converted to the latest FIRM Database schema	FIS Report	Working Standard	For Flood Risk Projects that have at least one FIRM panel produced in compliance with the current FIRM Panel Technical Reference, but whose FIS Report is not produced in compliance with the current FIS Report Technical Reference (i.e., the FIS Report is retaining its legacy format) the FIRM Legend and Notes to Users must be included as an appendix to the FIS Report per the current FIS Report Technical Reference.
502	12/8/2011	Existing standard. Already implemented.	FIRM Index	Working Standard	For FIRM Indexes produced in compliance with the current FIS Report Technical Reference, all required elements of the FIRM Index title block and Index collar shall be present and symbolized as outlined in the Technical Reference.
503	12/8/2011	Existing standard. Already implemented.	FIRM Index	Working Standard	For FIRM Indexes produced in compliance with the current FIS Report Technical Reference, the symbology and labeling of all features depicted on the FIRM Index shall adhere to the specifications outlined in the Technical Reference.
504	7/31/2013	Implemented for all projects once the NFHL for a community is converted to the latest FIRM Database schema	FIS Tables	Working Standard	For FIS Reports produced in compliance with the FIS Report Technical Reference, map repositories for all communities must be present and correct in the "Map Repositories" FIS Report table. Flood Risk Projects whose FIS Reports are not produced in compliance with the current FIS Report Technical Reference (i.e., the FIS Report is retaining its legacy format per FEMA Regional approval), but whose FIRM Index is produced in compliance with the FIS Report Technical Reference, must include a correctly populated "Map Repositories" table in the FIS Report. FIRM Indexes that are not produced in compliance with the FIS Report Technical Reference must include the map repository information on the Index.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
505	7/31/2013	Implemented for all projects once the NFHL for a community is converted to the latest FIRM Database schema	FIS Tables	Working Standard	FIS Reports not produced in compliance with the FIS Report Technical Reference (per FEMA Regional approval), but whose FIRM Index is produced in compliance with the Technical Reference, must include a correctly populated "Listing of NFIP Jurisdictions" table in the FIS Report. FIRM Indexes that are not produced in compliance with the FIS Report Technical Reference must include the Listing of Communities table on the FIRM Index.
506	2/1/2002	Existing standard. Already implemented.	Flood Profiles	Working Standard	Flood Profile notes and labels must be correct and agree with the FIRM and Floodway Data Table (if applicable).
507	12/1/2008	Existing standard. Already implemented.	FIS/FIRM	Working Standard	The FIRM, Flood Profiles and Floodway Data Tables must all be in agreement with each other as it relates to the depiction of flood hazards and hydraulic structures.

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508	7/31/2013	Implemented with all projects not yet final	Quality Management	Program Standard	Quality Reviews 1 through 8 must be conducted. Associated requirements for each review are as follows: **- QR1:** The draft FIRM database shall be uploaded to the MIP for auto-validation and must pass before QR2 is conducted. **- QR2:** The preliminary FIRM database shall be uploaded to the MIP for auto-validation and must pass before QR3 is conducted. **- QR3:** The preliminary FIS Report, FIRM, and SOMA shall be reviewed using standardized checklists located at http://www.fema.gov/library/viewRecord.do?id=7577 after the work has been self-certified as meeting FEMA standards. The FIS Report, SOMA, FIRM and FIRM database shall not be issued at preliminary until written certification is provided indicating that all issues cited at this review were properly addressed and resolved. **- QR4:** This review validates the Proposed FHD Notice, Appeal Period Docket, and 90-day Start Letter(s). If a 90-day appeal period is required, the proposed flood hazard determination notice information must be entered into the FHD Notices on the Web tool. An approved docket must be received from FEMA prior to the issuance of the 90-day Start Letter(s) **- QR5:** The FIRM database shall be auto-validated in the MIP and a visual review shall be conducted using standardized checklists located at http://www.fema.gov/library/viewRecord.do?id=7577 to compare the FIRM database to the printed FIRM and all cited issues must be resolved before the LFD will be distributed. **- QR6:** This review validates the LFD prior to the distribution of the final products. As part of the "Prepare LFD Docket" MIP task, the LFD Summary Sheet/Docket, FEDD Files, and LFD Questionnaire must be prepared and submitted, concurrent with QR5 and QR7. All cited issues must be resolved before the LFD will be distributed. **- QR7:** The final FIS Report, FIRM and associated paperwork shall be reviewed using standardized checklists located at

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					http://www.fema.gov/library/viewRecord.do?id=7577 before delivery to the MSC and all cited issues must be resolved before the LFD will be distributed. **- QR8:** A review of the FIS Report, FIRM, MSC paperwork, and delivery manifest shall be conducted by the FEMA Map Service Center using standardized checklists located at http://www.fema.gov/library/viewRecord.do?id=7577 and all cited issues must be resolved before delivery of the final products to the end users.
509	7/31/2013	Implemented with all projects not yet final	Quality Management	Program Standard	All Quality Compliance Check issues noted during the QR1 through QR8 process must be fully addressed, documented and resolved.
510	7/31/2013	Implemented with all projects not yet final	Quality Management	Program Standard	Standardized checklists must be used at FEMA-designated Quality Reviews. Those checklists, which are located at http://www.fema.gov/library/viewRecord.do?id=7577 must be retained as quality records, and delivered as part of the TSDN.
512	7/31/2013	Implemented with all projects not yet final	Quality Management	Program Standard	Self-Certification of compliance with FEMA standards must be provided before a QR3 review may be executed. A template for this requirement is available here (http://www.fema.gov/library/viewRecord.do?id=7577).
513	7/31/2013	Implemented with all projects not yet final	Quality Management	Program Standard	Written certification must be provided, documenting that all QR3 non-compliance citations were properly addressed and resolved, in order to complete the QR3 process. A template for this requirement is available at http://www.fema.gov/library/viewRecord.do?id=7577.
514	12/1/2008	Existing standard. Already implemented.	Quality Management	Program Standard	Following the QR4 review, any identified errors must be corrected prior to the 90-day Start letter distribution.
515	12/1/2008	Existing standard. Already implemented.	Due Process	Program Standard	The 90-day comment period for the Federal Register Proposed FHD Notice and the 90-day statutory appeal period must overlap by at least one day. If the 90-day appeal period does not begin prior to the end of the Federal Register 90-day comment period, in coordination with FEMA, the Federal Register publication must be withdrawn and the FHD notice must be republished.

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516	12/1/2008	Existing standard. Already implemented.	Due Process	Working Standard	The standard FHD Notice must be posted with the correct newspaper publication dates and appeal period start and end dates on FEMA's website prior to issuing the 90-day start letters.
517	12/1/2008	Existing standard. Already implemented.	Post-Preliminary Deliverables	Working Standard	The FIRM Database (including metadata) and the georeferenced FIRM image files must be submitted to the MIP and FEMA (or their designee) must be notified at least 60 days prior to the anticipated LFD date.
518	12/1/2008	Existing standard. Already implemented.	Quality Management	Program Standard	All outstanding map changes must be incorporated into the FIRM before proceeding with the QR5 database and visual review.
519	12/1/2008	Existing standard. Already implemented.	LFD	Program Standard	The FIS Report, FIRM, and FIRM database must pass QR5, QR6, and QR7 before the LFD may be distributed.
520	12/1/2008	Existing standard. Already implemented.	Post-Preliminary Deliverables	Program Standard	At least 45-days before the projected LFD date the final LFD letters, Part 67 Final Notice, and Final SOMAs must be submitted. No less than 4-weeks before the LFD the final LFD Summary Sheet/Dockets and LFD Questionnaires must be consolidated and sent to FEMA HQ for approval.
521	12/1/2008	Existing standard. Already implemented.	Quality Management	Program Standard	At least 60-days prior to the projected LFD date after receiving a passing QR5 auto-validation report for the FIRM database, the QR5 visual, QR6, and QR7 reviews at the "Produce Final Map Products" MIP task must be conducted.
522	12/1/2008	Existing standard. Already implemented.	LFD	Working Standard	As part of the "Prepare LFD Docket" MIP task, the LFD Summary Sheet/Docket, FEDD Files, and LFD Questionnaire must be submitted, concurrent with Quality Reviews 5 and 7.
523	4/1/2003	Existing standard. Already implemented.	SOMA	Working Standard	On the SOMA, structure removals must not be included in Category 1; LOMRs must not be included in Category 2; and LOMRs and single-determination LOMCs must not be included in Category 4.

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524	4/1/2003	Existing standard. Already implemented.	SOMA	Working Standard	When multiple determination LOMAs and LOMR-Fs include both removal and non-removal determinations, and all determinations remain the same based on the new or revised mapping, the case must be included in Category 2 and the new zone must be listed as 'X' in the MIP SOMA Tool; on the Revalidation Letter the new zone must be changed to 'Multiple' if it was formerly shown as "X".
525	4/1/2003	Existing standard. Already implemented.	SOMA	Working Standard	On the SOMA, the map number and map suffix must be listed in the new map panel field for each LOMC and the old map panel must be listed for the old panel field.
526	4/1/2003	Existing standard. Already implemented.	SOMA	Working Standard	All cases included on the SOMA in Category 2 must be listed with the new zone listed as 'X' in the MIP SOMA Tool.
527	4/1/2003	Existing standard. Already implemented.	SOMA	Working Standard	Any LOMCs issued prior to the effective date of the current respective FIRM panel must be included on the SOMA if they are listed on a current revalidation letter for the community.
528	4/1/2003	Existing standard. Already implemented.	SOMA	Working Standard	The SOMA must include the community name, CID, case number, date issued and project identifier for each LOMC listed.
529	4/1/2003	Existing standard. Already implemented.	SOMA	Working Standard	The FIRM Effective date must be listed on the Final SOMA.
530	7/31/2013	Applicable for LOMCs initiated after the effective date, but not retroactively for ongoing or completed LOMCs.	Coastal	Working Standard	All requests for flood map revisions based upon new or modified flood control structures shall include an analysis of the potential adverse impacts of the structure on flooding within, and adjacent to, the area protected by the structure. For coastal structures, this analysis must also evaluate the impacts of the structure on erosion within, and adjacent to, the protected area.

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531	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Program Standard	Metadata for non-regulatory flood risk datasets must comply with the Metadata Technical Reference.
532	1/1/2013	Existing standard. Already implemented.	Non-Regulatory Datasets	Program Standard	Attribute domains for non-regulatory flood risk datasets must comply with the Domain Tables Technical Reference.
533	10/1/2011	Existing standard. Already implemented.	FIRM Database	Program Standard	Metadata for FIRM databases must comply with the Metadata Profiles Technical Reference.
534	10/1/2011	Existing standard. Already implemented.	FIRM Database	Program Standard	Attribute domains for FIRM databases must comply with the Domain Tables Technical Reference.
535	7/31/2013	Implemented for all projects once the NFHL for a community is converted to the latest FIRM Database schema	LOMR Incorporation	Working Standard	When a PMR is processed that will only partially include an effective LOMR, all FIS Report components of the LOMR (including Flood Profiles and Floodway Data Tables) must be included in the revised FIS Report that is issued with the PMR. When the partially-included LOMR is re-issued, it must not include any FIS Report components and it will only include revisions for the FIRM panel(s) not revised with the PMR. The LOMR must be re-issued within three days of the FIS Report / FIRM effective date.
536	7/31/2013	Applicable for all coastal Flood Risk Projects in the data development stage where the erosion analyses have not been completed yet.	Coastal	Working Standard	For Atlantic Ocean and Gulf of Mexico coastal Flood Risk Projects, the 1-percent-annual-chance water level datum, above which the dune reservoir volume will be calculated for erosion analyses, will include storm surge, tidal effects, and wave setup components.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
537	7/31/2013	Applicable for LOMCs initiated after the effective date, but not retroactively for ongoing or completed LOMCs.	Coastal	Working Standard	LOMRs for Atlantic Ocean and Gulf of Mexico study areas where wave setup was evaluated as part of the effective coastal analysis shall use the effective still water elevations (including wave setup) for the calculation of dune reservoir volume in the dune erosion analysis. LOMRs where wave setup was not evaluated as part of the effective coastal analysis shall use the effective still water elevations (without wave setup) from the FIS Report for calculating dune reservoir volumes, unless the revision request includes new analyses of still water elevations and wave setup, in which case the reference water level shall include the wave setup component.
538	7/31/2013	For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)	Levee	Program Standard	FEMA will not fund any efforts solely related to certifying data for levee accreditation or making determinations of the levee's structural conditions.

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539	7/31/2013	For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)	Levee	Program Standard	The natural valley floodplain behind non-accredited levee systems shall be modeled and depicted as an SFHA, except when additional analysis indicates an alternate treatment. The natural valley floodplain behind non-accredited levee systems shall only be depicted as Zone D when freeboard deficient, sound reach, overtopping, and structural-based inundation procedures are implemented.
540	7/31/2013	For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)	Levee	Working Standard	Levee systems must be hydraulically independent whereby if one system fails, the area behind another system is not inundated.

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541	7/31/2013	For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)	Levee	Working Standard	A Local Levee Partnership Team (LLPT) must be established with participation of diverse stakeholders based on the complexity and scope of the levee system under evaluation. The options discussed by the LLPT members and FEMA's decisions regarding the appropriate analysis and mapping procedures to be used, must be documented and made available to stakeholders.
542	7/31/2013	For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)	Levee	Working Standard	If there are levee systems on both sides of a flooding source, or multiple systems that overlap, the extents of the natural valley area and reach specific SFHAs for each system will be analyzed independently assuming the other systems remain in place.

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<table>
<tr><th>SID #</th><th>Effective Date</th><th>Implementation Description</th><th>Category</th><th>Standard Type</th><th>Standard</th></tr>
<tr><td>543</td><td>7/31/2013</td><td>For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)</td><td>Levee</td><td>Working Standard</td><td>The following reach analysis approaches and corresponding data requirements shall be utilized when analyzing non-accredited levee systems:
<table>
<tr><th></th><th></th><th colspan="5">Reach Analysis Procedures</th></tr>
<tr><th>Data Element</th><th>Link to CFR</th><th>Sound Reach</th><th>Freeboard Deficient</th><th>Overtopping</th><th>Structural-Based Inundation</th><th>Natural Valley</th></tr>
<tr><td>Elevation Information for the Levee Crest and Toe</td><td>N/A</td><td>Required</td><td>Required</td><td>Required</td><td>Required</td><td>N/A</td></tr>
<tr><td>BFE + Freeboard Less than Levee Crest</td><td>44CFR65.10(b)(1)</td><td>Required</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>BFE Less than Levee Crest</td><td>N/A</td><td>Required</td><td>Required</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Operations and Maintenance Plan</td><td>44CFR65.10(c)</td><td>Required</td><td>Required</td><td>Required</td><td>Recommended</td><td>N/A</td></tr>
<tr><td>Structural Design Requirements</td><td>44CFR65.10(b)(2)
44CFR65.10(b)(4)
44CFR65.10(b)(5)
44CFR65.10(b)(6)
44CFR65.10(b)(7)</td><td>Required</td><td>Required</td><td>Required</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Inspection Reports</td><td>44CFR65.10(c)(2)(iv)</td><td>Required</td><td>Required</td><td>Required</td><td>Recommended</td><td>N/A</td></tr>
<tr><td>Evaluation of Overtopping Erosion Potential</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Required</td><td>N/A</td><td>N/A</td></tr>
</table></td></tr>
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544	7/31/2013	For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)	Levee	Working Standard	The final SFHA delineation shown on the FIRM landward of the non-accredited levee system shall be based on a composite of flooding results from each independently analyzed reach, any interior drainage flooding of the system, and ponding against the landward side of the levee.
545	7/31/2013	For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)	Levee	Working Standard	The resulting floodplain from the analysis of a Structural Based Inundation reach must reflect the fact that a breach could occur at any location along the reach.

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546	7/31/2013	For all non-accredited levee projects that were previously on-hold and for newly initiated flood risk projects after the effective date, or after Congressional LAMP briefing. (whichever is later)	Levee	Working Standard	If BFEs are to be shown on the FIRM landward of non-accredited levee systems, they shall be based on the highest elevation of the composite analysis and mapping.
547	11/30/2014	Existing standard. Already implemented.	Elevation Data	Working Standard	If topographic breaklines are produced and submitted, the Topographic Breakline Topology Rules outlined in the Data Capture Technical Reference must be followed.
549	11/30/2014	Existing standard. Already implemented.	Metadata	Working Standard	The metadata files submitted for each applicable task must comply with the Metadata Profiles Technical Reference and must document the data being submitted and include the following elements: • Identification Information • Data Quality Information • Spatial Reference Information • Entity and Attribute Information • Distribution Information • Metadata Reference Information
550	4/1/2003	Existing standard. Already implemented.	Letter of Map Revision (LOMR)	Program Standard	If a LOMR results in a new or increased BFE or a new or increased SFHA, the requester must notify the property owner(s) of the impact of the LOMR on their property.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
551	1/1/2013	Existing standard. Already implemented.	PMR	Working Standard	For PMRs, the footprint shall be defined as the boundary of the FIRM panel(s) affected by the PMR's study area.
552	12/1/2008	Existing standard. Already implemented.	Quality Management	Program Standard	A Quality Management Plan that prescribes protocols for ensuring consistent compliance with FEMA Standards must be in place.

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553	4/1/2003	Existing standard. Already implemented.	SOMA	Program Standard	LOMCs shall be categorized on the SOMA as follows: Category 1 (LOMCs Incorporated) - Includes those LOMRs (and some LOMAs and LOMR-Fs) whose results are unaffected by new or revised flood hazard data, and whose results can and will be incorporated into the revised FIRM panel(s). Large metes-and-bounds or multi-lot property removal LOMR-Fs are sometimes incorporated through Category 1 when scale limitations do not prohibit it; although typically, these LOMAs and LOMR-Fs will be revalidated through Category 2. Structure removal (both single and multiple determination) LOMCs cannot be incorporated due to scale limitations and therefore shall not be included in Category 1. Category 2 (LOMCs Not Incorporated) - Includes those LOMAs and LOMR-Fs whose results are unaffected by new or revised flood hazard data but could not be incorporated into the revised FIRM panel because of map scale limitations, or because the property or structure was determined to be outside the SFHA as shown on the effective FIRM panel and remains outside the SFHA on the revised FIRM panel(s). These LOMCs are included on the Revalidation Letter that becomes effective one (1) day after the revised FIRM panels become effective. Multiple-determination LOMCs that include denials may be included in this category if all determinations in the LOMC are unaffected by the new or revised flood hazard data. Category 3 (LOMCs Superseded) - Includes those LOMCs whose results will not be reflected on the revised FIRM panel because the flood hazard data on which the determinations are based are being superseded by new detailed flood hazard data, or the information available was not sufficient to make a determination. Category 4 (LOMCs To Be Redetermined) - Includes those LOMAs and LOMR-Fs issued for multiple lots or structures for which new determinations must be

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					made because the determination for one or more properties or structures has changed as a result of the new or revised flood hazard information, and therefore cannot be revalidated.
555	10/1/2011	Existing standard. Already implemented.	National Flood Hazard Layer (NFHL)	Working Standard	RFHL to NFHL submissions must include all up-to-date revisions and study data inclusive in a DFIRM ID.
556	7/31/2013	Implemented with all new flood risk projects initiated in FY13.	Stakeholder Engagement	Program Standard	All Flood Risk Projects must have a communications plan designed to keep project stakeholders informed of all key decisions, draft findings and finished outputs. The plan shall also be designed to regularly engage key stakeholders in dialog about local risks and potential actions to manage and reduce those risks.
600	11/1/2010	Existing standard. Already implemented.	Appeals	Program Standard	An administrative appeal period must be offered for physical map revisions and letters of map revision where: • New BFEs or base flood depths are proposed or currently effective BFEs or base flood depths have been modified; • New SFHAs are proposed or the boundaries of currently effective SFHAs have been modified; • New SFHA zone designations are proposed or currently effective SFHA zone designations have been modified; or • New regulatory floodways are proposed or the boundaries of currently effective floodways that have been modified. In order to qualify as an appeal, scientific and/or technical data demonstrating these changes are incorrect must be provided.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
601	5/30/2014	Implemented for all projects where the 90 day statutory appeals period has not yet begun.	FIS/FIRM	Program Standard	The Community Map Repository address for each community listed in the Federal Register Flood Hazard Determination notice must be a physical address (i.e., not a P.O. Box) confirmed by the community. Additionally, the repository address must be consistent among all related products (FIS, FIRM Index, FIRM Database, FHD Web tool, and Federal Register), both hard copy and online versions, before starting the statutory 90-day appeal period.
602	5/30/2014	Implemented for any project not yet at preliminary.	Levee	Program Standard	For the analysis and mapping of flood hazards associated with levee systems, if available, data and documentation in the USACE National Levee Database (NLD) or from local communities, tribal entities or other Federal/State agencies should be leveraged.
603	11/30/2014	Implemented for any new community request received after March 21, 2014	Levee	Program Standard	Requests for a determination of adequate progress toward completion of flood protection systems must meet the data and documentation requirements outlined in 44 CFR 61.12, except where superseded by Section 19, Part a, of the Homeowner Flood Insurance Affordability Act, 42 U.S.C. § 4014(e). Zone A99 requests may be submitted for projects constructing or reconstructing flood protection systems. Requests will not be limited to projects with Federal funding, and the present value of the system can be used to meet the requirements of 44 CFR 61.12.b.
604	11/30/2014	Implemented for any new community request received after March 21, 2014	Levee	Program Standard	Map revision requests to reflect flood control system restoration projects with a Zone AR designation must meet the data and documentation requirements outlined in 44 CFR 65.14, except where superseded by Section 19, Part b, of the Homeowner Flood Insurance Affordability Act, 42 U.S.C. § 4014(f). Zone AR requests may be submitted for levees in riverine and coastal areas, except when the landward flood zone of the existing structure would be defined as a Coastal High Hazard Area. Requests will be reviewed without regard to Federal funding or participation, and restoration projects must be complete or meet the requirements of 44 CFR 61.12 within a specified timeframe, not to exceed 10 years, from the date the community submits the request for a Zone AR determination by FEMA.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
605	11/30/2014	Effective immediately	National Flood Hazard Layer (NFHL)	Program Standard	Flood Insurance Rate Maps, FIRMettes, and NFHL Databases are the official FEMA digital products. The official FEMA digital products and printed versions produced from the official digital products are all equivalent to each other and represent official FEMA designations of the areas of special flood hazard, base flood elevations, insurance risk zones and other regulatory information, provided that all other geospatial data shown on the printed product meets or exceeds any accuracy standard promulgated by FEMA. Products using FEMA's regulatory data must include a statement that they conform to this standard in order to be used in place of the official FEMA digital products.
606	11/30/2014	Existing standard. Already implemented.	National Flood Hazard Layer (NFHL)	Program Standard	When a coordinate grid is shown on the FIRM or when the FIRM or NFHL Database version is available, the horizontal location of the flood hazard information is defined with respect to the primary coordinate system shown on the FIRM or stored in the FIRM or NFHL Database product. The horizontal location of the flood hazard information is not defined by its relationship to the base map features such as streets. If there are conflicting interpretations of the precise horizontal location of the areas of special flood hazard, the conflict shall be resolved using the grid coordinates shown on the printed FIRM or stored in the FIRM or NFHL Database products rather than the base map features.
607	11/30/2014	For all projects where the FIRM database has not yet been submitted to the NFHL	National Flood Hazard Layer (NFHL)	Working Standard	NFHL submittals must not contain a single dataset (i.e. DFIRM_ID) which includes future-effective LOMRs with effective dates separated by more than one business day.

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608	11/30/2014	For all projects where the FIRM database has not yet been submitted to the NFHL	National Flood Hazard Layer (NFHL)	Working Standard	rFHL submittals must be submitted in a geodatabase format that matches the current NFHL schema in the FIRM Database Technical Reference.
609	11/30/2014	For all projects where the FIRM database has not yet been submitted to the NFHL	National Flood Hazard Layer (NFHL)	Working Standard	DFIRM study data incorporated into the NFHL must be obtained from the FINAL_DFIRM_DB task MIP folder for the associated Risk MAP project case number.
610	11/30/2014	For all projects where the FIRM database has not yet been submitted to the NFHL	National Flood Hazard Layer (NFHL)	Working Standard	All NFHL data superseded by a Risk MAP or LOMR project must be removed from the rFHL prior to submission, and the NFHL must replace all data for a submitted dataset (i.e. DFIRM_ID) in its entirety.
611	11/30/2014	For all projects where the FIRM database has not yet been submitted to the NFHL	National Flood Hazard Layer (NFHL)	Working Standard	NFHL submittals must contain a unique identifier within the primary key fields for all records within a dataset (i.e. DFIRM_ID) and maintain all primary and foreign key relationships as defined in the FIRM Database Technical Reference.

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612	5/31/2015	Effective immediately	Project Management	Program Standard	Flood Risk Projects must follow the Key Decision Points (KDPs) process and each KDP must be documented. A Flood Risk Project shall not advance in its project lifecycle beyond a KDP without Regional and HQ approval. The 6 distinct KDPs: - KDP 0: decision to initiate a Flood Risk Project or group of Flood Risk Projects. - KDP 1: decision to move forward with a Flood Risk Project through data development, risk awareness, and/or outreach tasks - KDP 2: decision to develop Preliminary FIRM products - KDP 3: decision to distribute Preliminary FIRM products to communities - KDP 4: decision to initiate the Appeal Period - KDP 5: decision to issue the LFD
613	5/31/2015	Effective immediately	Coastal	Program Standard	FEMA does not issue CLOMA or LOMA determinations in V zones where the primary frontal dunes (PFDs) define the inland limits of V zones.
614	7/31/2015	Effective immediately	Coastal	Program Standard	FEMA will only use whole foot BFEs for LOMA or CLOMA determinations where effective flood hazard areas are the result of coastal flood hazard analysis.
615	7/31/2015	Effective immediately	Appeals	Program Standard	The Scientific Resolution Panel must issue a report detailing the panel findings in writing to the community and FEMA no later than 90 days after being formed. The Panel Sponsor must publicly identify the date that an SRP was formed on the SRP website.

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SID #	Effective Date	Implementation Description	Category	Standard Type	Standard
616	7/31/2015	Effective immediately	Letter of Map Revision (LOMR)	Program Standard	A LOMR or CLOMR requester shall be exempt from submitting a review or processing fee for a request that is based on a project where: (1) the primary purpose is habitat restoration; and (2) where the habitat restoration project is funded in whole or in part with Federal or State-funds. For the purposes of this fee exemption, "habitat restoration" will have the same meaning as the term "habitat restoration" in the Partners for Fish and Wildlife Act, 16 U.S.C. § 3772(5). This exemption includes projects for dam removal, culvert redesign or installation, or the installation of fish passage if the primary purpose is habitat restoration.
617	7/31/2015	Effective immediately	Prelim Distribution	Program Standard	Congressional notifications required under 42 USC 4101b (d)(1)(G) and (H) related to issuance of preliminary maps shall be provided in the monthly "Notice to Congress: Monthly Update on Flood Mapping" report. Issuance of initial preliminary maps and revised preliminary maps must be included.
618	11/30/2015	Effective immediately	Letter of Map Revision (LOMR)	Working Standard	All LOMRs issued shall have all revised FIRM Database items prepared in accordance with the FIRM Database Technical Reference and incorporated into the National Flood Hazard Layer (NFHL) with a polygon showing a LOMR area of revision.
619	11/30/2015	Effective Immediately	Coastal	Program Standard	When revising the dune feature identified as the Primary Frontal Dune in an effective FIS, the revised feature must be as continuous or more continuous than the effective PFD. This is especially important in areas with multiple ridges throughout a dune field, areas with man-made dunes, and property-specific revisions, including requests that the PFD designation be removed altogether. Community coordination may be required to make this assessment.

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Appendix B
Acronyms and Abbreviations Used in the Risk MAP Standards

Item	Full Translation
2D	Two-Dimensional
AoMI	Areas of Mitigation Interest
BFE	Base Flood Elevation
BW-12	Biggert-Waters Flood Insurance Reform Act of 2012
CBRS	Coastal Barrier Resources System
CCO	Consultation Coordination Officer
CDS	Customer and Data Services
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
CID	Community Identifier
CIS	Community Information System
CLOMA	Conditional Letter of Map Amendment
CLOMR	Conditional Letter of Map Revision
CLOMR-F	Conditional Letter of Map Revision based on Fill
CNMS	Coordinated Needs Management Strategy
CRS	Community Rating System
CSLF	Changes Since Last FIRM
CTP	Cooperating Technical Partner
CVA	Consolidated Vertical Accuracy
DBF	Database File
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map

FEMA

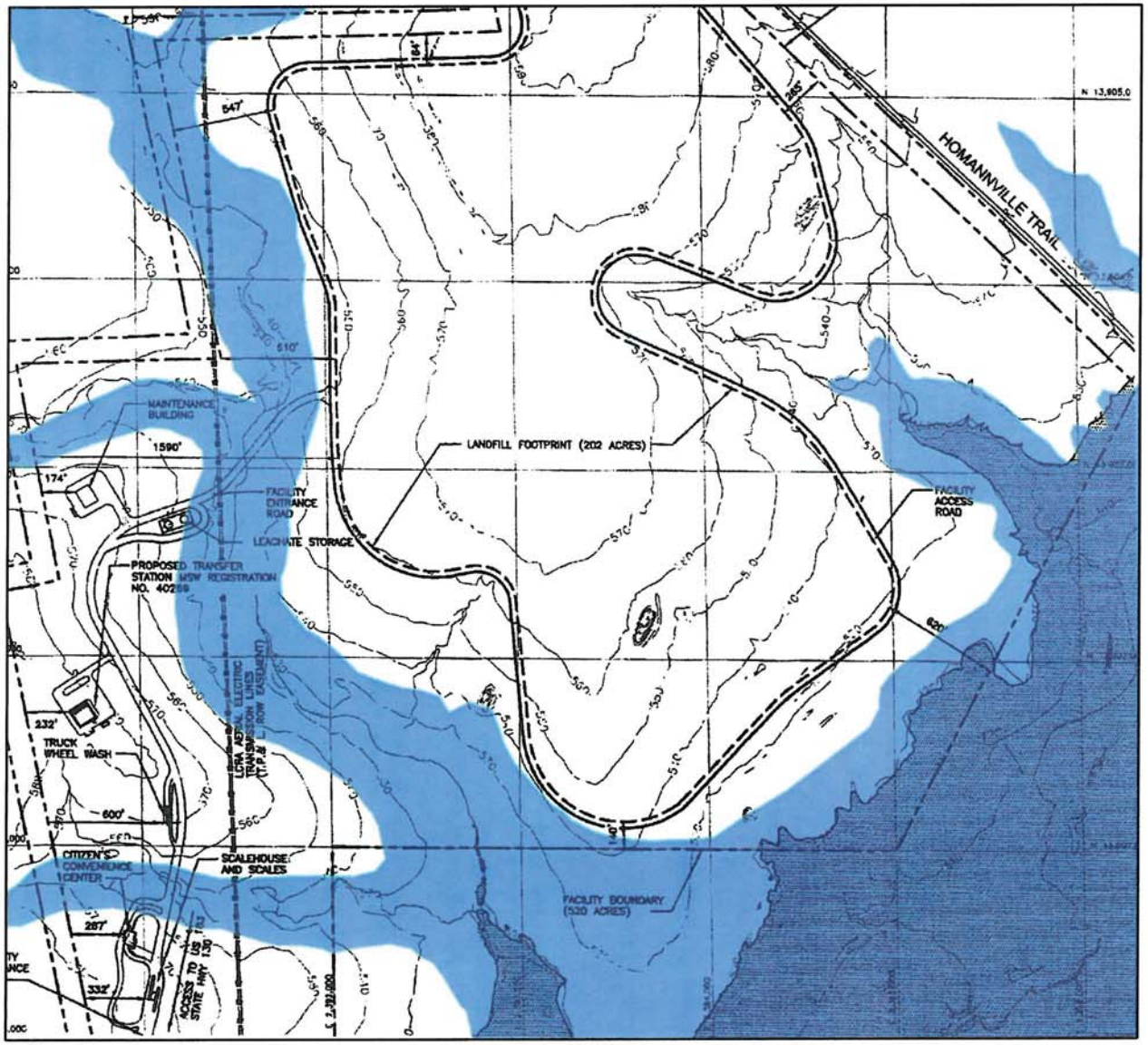
Item	Full Translation
Esri	Environmental Systems Research Institute
ETJ	Extraterritorial Jurisdiction
FBFM	Flood Boundary and Floodway Map
FBS	Floodplain Boundary Standard
FDT	Floodway Data Table
FEDD	Flood Elevation Determination Docket
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Map
FHD	Flood Hazard Determination
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRD	Flood Risk Database
FRM	Flood Risk Map
FRR	Flood Risk Report
FVA	Fundamental Vertical Accuracy
GCS	Geographic Coordinate System
GIS	Geographic Information System
H&H	Hydrologic & Hydraulic
HFIAA	Homeowner Flood Insurance Affordability Act of 2014
HQ	Headquarters
HUC	Hydrologic Unit Code
KDP	Key Decision Point
LFD	Letter of Final Determination
Lidar	Light Detection and Ranging or Laser Imaging Detection and Ranging

FEMA

Item	Full Translation
LiMWA	Limit of Moderate Wave Action
LLPT	Local Levee Partnership Team
LODR	Letter of Determination Review
LOMA	Letter of Map Amendment
LOMC	Letter of Map Change
LOMR	Letter of Map Revision
LOMR-F	Letter of Map Revision based on Fill
MAF/TIGER	Master Address File/Topologically Integrated Geographic Encoding and Referencing
MIP	Mapping Information Platform
MSC	Map Service Center
MXD	ArcMap Document (file extension)
NAD83	North American Datum 1983
NAVD88	North American Vertical Datum 1988
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program
NGO	Non-Governmental Organization
NPS	Nominal Pulse Spacing
NSRS	National Spatial Reference System
NSSDA	National Standard for Spatial Data Accuracy
NVA	Non-vegetated Vertical Accuracy
NVUE	New, Validated, or Updated Engineering
OFA	Other Federal Agency
PAL	Provisionally Accredited Levee
PDF	Portable Document Format

FEMA

Item	Full Translation
PFD	Primary Frontal Dune
PLSS	Public Land Survey System
PMR	Physical Map Revision
QA	Quality Assurance
QA/QC	Quality Assurance / Quality Control
QR	Quality Review
RFHL	Regional Flood Hazard Layer
RPO	Regional Project Officer
SFHA	Special Flood Hazard Area
SHMO	State Hazard Mitigation Officer
SHP	Shapefile (file extension)
SOMA	Summary of Map Actions
SRP	Scientific Resolution Panel
SVA	Supplemental Vertical Accuracy
TIN	Triangulated Irregular Network
TSDN	Technical Support Data Notebook
TWL	Total Water Level
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VVA	Vegetated Vertical Accuracy
WSEL	Water Surface Elevation
XML	Extensible Markup Language (file extension)
XS	Cross Section



FEMA Mapped 100-Year Floodplain

Floodplain based on FEMA National Flood Hazard Layer incorporating the Flood Insurance Rate Map database and any Letters of Map Revision. Published 1/28/2016. Obtained through TNRIS.

Facility Site Plan submitted as Figure IIA.12 in 130 Environmental Park Type I Permit Application. Sealed by K. D. Maroney on March 11, 2015.

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GLENROSE ENGINEERING

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STATE OF TEXAS
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PROFESSIONAL ENGINEER
June 26, 2016

Proposed 130 Environmental Park Landfill
Facility Site Plan and 100-year Floodplain

June 21, 2016