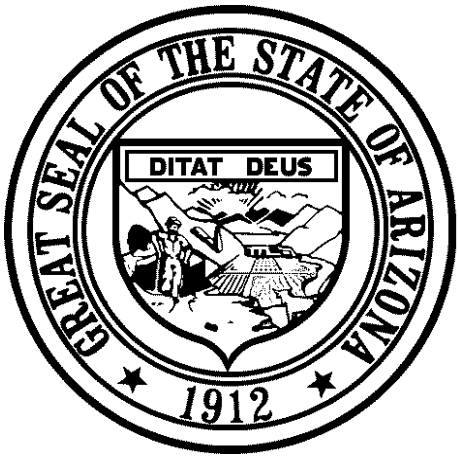
ARIZONA DEPARTMENT OF WATER RESOURCES



State Standard 1

Instructions for

Organizing and Submitting

Technical Support Data Notebooks (TSDN)

for Flood Studies

ARIZONA DEPARTMENT OF WATER RESOURCES

INSTRUCTIONS FOR

FLOOD STUDY TECHNICAL SUPPORT DATA NOTEBOOKS

The Director of the Arizona Department of Water Resources (ADWR) under the authority outlined in ARS 48-3605(A) establishes the following criteria for all flood studies submitted to local government agencies (hereinafter referred to as "local governments") or the Federal Emergency Management Agency (FEMA) by communities, counties or individuals in Arizona.

Flood studies submitted to local governments or FEMA for the purpose of delineating floodplains or revising existing floodplains are to meet the criteria as set forth herein unless the local government has in effect criteria that results in the same or greater level of information.

This State Standard is effective August 2012. State Standard 1 replaces State Standard 1-97 and State Standard Attachment 1-97, adopted on November 1, 1997. Please discard all copies of the superseded standard and attachment.

Copies of this State Standard can be obtained by contacting ADWR. For more information, visit the ADWR website at www.azwater.gov.

DISCLAIMER OF LIABILITY

The Arizona Department of Water Resources is not responsible for the application of the methods outlined in this standard and accepts no liability for their use.

The Arizona Department of Water Resources reserves the right to modify, update, or otherwise revise this document. Questions regarding information contained in this document and/or floodplain management should be directed to the local floodplain administrator or by contacting the Arizona Department of Water Resources.

TABLE OF CONTENTS

List of Acronyms

ADWR – Arizona Department of Water Resources
ARS – Arizona Revised Statutes
CAD – Computer Aided Design
CLOMR – Conditional Letter of Map Revision
DXF – Drawing Exchange Format file
ERM – Elevation Reference Mark
FEMA – Federal Emergency Management Agency
FIS – Flood Insurance Study
GIS – Geographic Information System
LOMR – Letter of Map Revision
NWS – National Weather Service
PMR – Physical Map Revision
SS – State Standard
TSDN – Technical Support Data Notebook
USGS – United States Geological Survey
WSEL – Water Surface Elevation

I. INTRODUCTION

Overview

Arizona Department of Water Resources (ADWR) has established criteria that affect flood studies submitted to local governments or to the Federal Emergency Management Agency (FEMA). This technical documentation standard is to be applied for all Level 3 Methodology studies as defined in ADWR State Standards and local guidance as needed.

The purpose of State Standard 1 (SS1) is to ensure that adequate technical documentation for all flood studies will be submitted and available in the future. Past experiences with the documentation available from studies completed for FEMA indicate that many of the technical details of the studies have been misplaced or are unavailable. This results in additional costs to public agencies and private individuals whenever studies need to be referenced, updated, or changed. In addition, adequate review by local governments or FEMA of any proposed revisions or additions to flood hazard areas will ensure that the quality of all studies remains satisfactory and that their content is consistent.

This State Standard 1 document requires the study preparer to incorporate all essential technical data into one comprehensive data package to be known as the Technical Support Data Notebook (TSDN). This publication outlines the documentation indexing system to be used in preparation of the TSDN.

Submittals to both local governments and FEMA generally follow the same document format and are intended to contain similar level of detail and documentation. It is important for floodplain study preparers to be aware that there are minor differences in the submittal requirements between local governments and FEMA submittals. In particular, Section 2 and Section 7 of the TSDN differ in content between local government submittals and FEMA submittals. All other required sections of the TSDN are similar in their format and content requirements.

In addition, this document format may be adapted for drainage reports where a local government does not provide a drainage report format or standard. However, the local government should be consulted before using this document for drainage reports to verify if it is acceptable to that agency.

TSDNs for Submittal to Local Governments

Local governments typically contemplate localized flooding or flood hazard areas that may be administratively enforced but are not identified as FEMA flood hazards, commonly referred to as a Special Flood Hazard Area. It is important to consult with the local government for TSDN submittal or alternative study and/or submittal requirements.

Please refer to Table 1 for a detailed outline of the contents required for TSDN submittals to local governments. The outline for a TSDN submitted to local governments is different from submittals to FEMA. Section 2 of the TSDN is used for abstract data as listed and described in the Appendix. Section 7 is reserved for FIS information for FEMA submittals and is therefore not applicable for local government submittals. The remaining sections of the TSDN are used as the main body of the report and should contain detailed descriptions of the substantiating data, assumptions, results, and conclusions for the floodplain delineation. Refer to Table 1 and Table 2 for a direct comparison of

the outlines used for the two types of submittals. Refer to Sections III and V of this document for additional information.

TSDNs for Submittal to FEMA

TSDNs for submittal to FEMA are conducted for flood-related studies that relate to or consist of the application and certification of forms for Conditional Letters of Map Revision (CLOMR), Letters of Map Revision (LOMR), and Physical Map Revisions (PMR).

Please refer to Table 2 for a detailed outline of the contents required for TSDN submittals to FEMA. Section 2 of the FEMA submittal consists of the various FEMA forms that are required to be submitted based on project type. Section 7 is comprised of the required Flood Insurance Study (FIS) information. The remaining sections of the TSDN are to be used for supplemental information that cannot fit within the space allowed on the appropriate FEMA form. FEMA MT-2 Form 3 (Hydrologic Information Form), for instance, would be expanded using Section 4 of the TSDN. Maps are to be organized and located as described in the TSDN outline. Refer to Table 1 and Table 2 for a direct comparison of the outlines used for the two types of submittals. Refer to Sections III and V of this document for additional information.

II. TSDN STRUCTURE

Local Government Submittals

Table 1

General Structure of a TSDN

TSDN Outline

Section	Local Government Submittals
TP	Title Page
TOC	Table of Contents
1	Introduction
2	Local Government Abstract
3	Survey and Mapping Information
4	Hydrology
5	Hydraulics
6	Erosion, Sediment Transport, and Geomorphic Analysis
7	N/A
Appendix A	References
Appendix B	General Documentation and Correspondence
Appendix C	Survey Field Notes
Appendix D	Hydrologic Analysis Supporting Documentation
Appendix E	Hydraulic Analysis Supporting Documentation
Appendix F	Erosion, Sediment Transport, and Geomorphic Analysis Supporting Documentation
Electronic Submittal	TSDN in PDF format on medium acceptable to submittal agency. Model and model results provided in original program format. Other supporting data such as topo, GIS, CAD files as required by the submittal agency.
I	Hydrology Exhibit Maps
II	Hydraulics Exhibit Maps
III	Floodplain Work Study Maps

FEMA Submittals

Table 2

General Structure of a TSDN

TSDN Outline

Section	FEMA Submittals
TP	Title Page
TOC	Table of Contents
1	Introduction
2	FEMA Forms
3	Survey and Mapping Information
4	Hydrology
5	Hydraulics
6	Erosion, Sediment Transport, and Geomorphic Analysis
7	Draft FIS Data
Appendix A	References
Appendix B	General Documentation and Correspondence
Appendix C	Survey Field Notes
Appendix D	Hydrologic Analysis Supporting Documentation
Appendix E	Hydraulic Analysis Supporting Documentation
Appendix F	Erosion, Sediment Transport, and Geomorphic Analysis Supporting Documentation
Electronic Submittal	TSDN in PDF format on medium acceptable to submittal agency. Model and model results provided in original program format. Other supporting data such as topo, GIS, CAD files as required by the submittal agency.
I	Hydrology Exhibit Maps
II	Hydraulics Exhibit Maps
III	Floodplain Work Study Maps

Each TSDN is to follow the structure set forth in Table 1 or Table 2. The structure is presented in more detail in Sections III and V of this document. The following are guidelines for use of the structure in preparing TSDNs. Refer to Section VI for general standards for the appearance of the materials contained in the TSDN.

Guidelines for Use of the TSDN Structure

1. **TSDNs Submitted To Local Governments:** The abstract forms in the Appendix shall be used for Section 2 of the TSDN instead of the FEMA forms. Each field of the abstract form is explained in Section IV of this document.

2. **TSDNs Submitted To FEMA:** The latest edition of the MT-2 FEMA form series shall be used for Section 2 of the TSDN. Refer to Section V for more information. The remaining sections and appendices shall be used to organize and document overflow and supplemental information that cannot fit within the room allotted on the FEMA forms. TSDN sections that are not pertinent are to be identified accordingly in the text. The current FEMA forms can be obtained in digital format on the Internet at: HTTP://www.fema.gov/library.

   Flood study preparers should contact FEMA to verify the submittal location and preferred method of submittal.

3. **Multiple Volume TSDNs:** TSDNs that are too large to fit within one binder may be split into multiple volumes. A possible procedure is to split the information in sequential order based on the TSDN outline. Other methods are possible and may be used with the approval of the reviewing agency.

4. **Exhibits and Maps:** Exhibits and maps are to be included in pockets at the back of the TSDN whenever possible. Larger maps, such as the Work Study Maps, can be provided bound and rolled under separate cover. It is preferable that map pockets for folded maps be made of plastic or a similarly durable product.

5. **Duplication:** Duplication of data within the TSDN is to be avoided where possible. Use cross references to avoid duplication.

6. **Expansion of TSDN:** The TSDN outline can be expanded beyond Section 7 and Appendix F. This may be desirable when using the TSDN format for a drainage design report or drainage master plan.

   The TSDN outline can be broken down into subsections as necessary for a particular TSDN. For example, Section 3.2.2 Physical Parameters could be broken down into sub-sections as follows:

   Section 3.2.2.1 Watershed Subbasin Parameters
   Section 3.2.2.2 Reach Route Parameters
   Section 3.2.2.3 Storage Route Parameters

7. **Sections That Are Not Used and Restructuring:** Sections that are not appropriate for a particular study must still be included in the TSDN. Make a statement or reference accordingly under the unused section. Renumbering of TSDN sections in the main body for other purposes will not be permitted.

8. **Non-Traditional Cases**: Non-traditional cases may include but are not limited to the following: two-dimensional hydraulic modeling and alluvial fan analysis. In general, these types of analyses should be incorporated within the existing TSDN outline as much as possible. For example, two–dimensional hydraulic modeling can expand Section 5.3, Parameter Estimation to include parameters relevant to two-dimensional modeling. This can be achieved through the inclusion of supplemental sub-sections (i.e., 5.3.3 – "Grid Size" and 5.3.4 – "Obstructions to Flow") to the original TSDN outline. Deviations from the TSDN outline must be approved by the local government agency.

9. **Hard Copies of TSDN:** Verify the number of hard copies required by the local government for submittal.

III. TSDN OUTLINE FOR LOCAL GOVERNMENT SUBMITTALS

The material contained within the TSDN will be organized as listed and described below. Sections that are not applicable should be denoted as such and are still contained in the TSDN. The numbering system should not be changed. Specific minimum standards are listed when appropriate.

The following is the detailed outline of the TSDN:

Title Page: The title page is to contain the name and location of the study, the name, address, phone number, and project number (or contract number) of the study requestor, the study preparer, and the date of preparation. The title page must include the professional registration seal of the study preparer. The title page shall also be titled "draft" if it is not in final form.

Table of Contents: The table of contents is to include a list of figures, a list of tables, a list of appendices, and the professional registration seal of the study preparer.

Section 1: Introduction

The introduction is to be structured to provide an overview of the material contained in the TSDN. The introduction should include the following and is to be organized at the discretion of the study preparer:

- Purpose of study (CLOMR, LOMR, new delineation, hydrology only or hydraulics only). Describe why a CLOMR or LOMR is necessary and the reasons for any revisions to hydrology or hydraulics.
- Authority for study (client name, contract number and date, project manager, etc).
- Location of study reach by section, township, range, community, and county. Provide a location map and vicinity map.
- Brief statement of methodology used for hydrology and hydraulics.
- Acknowledgments.
- Brief description of study results.

Section 2: Local Government Abstract

Local Government Submittals - TSDN Section 2 is to contain the complete Study Documentation Abstract for submittals to Local Governments. The purpose of the Local Government Abstract is to provide a number of key facts about the study being documented. A sample abstract form is contained in Appendix A. Refer to Section IV of this document for an explanatory list of the required information for the Study Documentation Abstract for Local Government Submittals and the complete Study Documentation Abstract form in Appendix A.

Section 3: Survey and Mapping Information

3.1 Digital Projection Information

Provide a description of the electronic data available to the reviewer. This may include image files, GIS, or CAD files associated with the topo, aerial photos, or other supporting data. The coordinate system of the digital data should be discussed and metadata provided to document the source, date, and coordinate system of the data.

3.2 Field Survey Information

Provide a description of all survey information used in the study, including the dates when the survey work was performed. Document the professional responsible for field work, and the company name and project number if the work was completed by a sub-consultant. Provide a description of how the field notes in Appendix C are organized, and any other pertinent information necessary to understand the information in Appendix C. The information in Appendix C is to be sealed by a Land Surveyor registered in the State of Arizona.

3.3 Mapping

Provide a description of the mapping and map control used in the study. Provide a narrative overview identifying the mapping datum (both horizontal and vertical), date of the aerial photography, mapping scale, and contour interval. Document the date of the last overall vertical control survey upon which the referenced benchmarks are based. Provide additional documentation verifying the accuracy of benchmarks located in areas of known subsidence. Describe the flight path followed, the time-of-day photographs were taken, the number of stereo models used, and the photo scale. Distinguish between mapping used for hydrology and mapping used for hydraulics. Document the professional responsible for developing the mapping, and the company name and project number if the work was completed by a sub-consultant. Submittal of documentation to validate the topographic mapping accuracy through additional field survey may be required.

Section 4: Hydrology

4.1 Method Description

Provide a narrative description of the hydrologic methods or models used in the study. Include the model name, date, and source.

4.2 Parameter Estimation

This section and its subsections should include a complete description of the methodology and calculations used to develop the hydrology.

4.2.1 Drainage Area Boundaries

Describe the limits of the study watershed and the general watershed characteristics. Provide a general watershed map of the study area that is legible and to scale, showing the study area boundary, major sub-basin boundaries, and concentration points.

4.2.2 Watershed Work Maps

Describe the watershed work maps prepared as a part of the study and included as exhibit drawings. Discuss the nomenclature used to name subbasins, concentration points, routing reaches, reservoir routes, and flow diversions. Exhibits should be prepared covering the watershed, to scale, that depict the following, as a minimum:

1. Subbasin boundaries and concentration points,
2. Time-of-concentration or lag flow paths,
3. Hydrograph routing paths,

4. Soils boundaries, and
5. Land-use boundaries.

The exhibits are to be placed in pockets at the end of the TSDN, or bound under separate cover if too voluminous. Reduced copies of the exhibits are to be placed in this section if practical.

4.2.3 Gage Data

Identify and discuss locations of any National Weather Service (NWS), USGS, or other agency gage stations in or adjacent to the region and watershed in relation to historic precipitation, watershed runoff, and statistical parameters.

4.2.4 Statistical Parameters

Provide a narrative discussion of the data record and information available on precipitation, runoff and discharge for the region and the study watershed. Assess the adequacy and applicability of the record for use with Water Resources Council Bulletin 17B, (March 1982) or subsequent version. Discuss factors that may affect the reasonableness of frequency analysis for the study watershed and describe why or why not the methods in Bulletin 17B are used for estimating peak discharges for the study. Refer to Statistical Summaries of Streamflow Data and Characteristics of Drainage Basins for Selected Streamflow-Gaging Stations in Arizona Through Water Year 1996, USGS Water-Resources Investigations Report 98-4225 or subsequent version for statewide data and results of Log-Pearson Type III analyses.

4.2.5 Precipitation

Provide further detail than described in Section 4.2.4. The additional detail should include a narrative discussion with supporting data of the historic precipitation records in or adjacent to the study watershed. Discuss the watershed size, the nature of historic flooding, the types of storms that result in flooding, and the typical aerial extent of historic storms. Identify the rainfall duration and distribution pattern and the point rainfall values used for hydrologic modeling. Relate the hypothetical model design precipitation and distribution from stated reference sources to the historic record and statistical parameters.

4.2.6 Physical Parameters

Describe the methods used for estimation of the physical hydrologic parameters, such as rainfall losses, the unit hydrograph used, and time-of-concentration or lag. The discussion of rainfall losses should include the soils information used including the data source, surface retention losses, percent impervious estimates for natural and developed watersheds, and the effects of vegetation cover. Provide summary tables listing the physical parameters for every subbasin in the hydrologic models.

4.3 Issues Encountered During the Study

4.3.1 Special Issues and Solutions

Special issues are unique situations that are not addressed by the standard TSDN outline. Provide a narrative discussion of any special issues that were encountered during the study. Describe the alternatives examined and the final solution used for each issue. Examples may include burned watersheds, overgrazed areas, or non-default values.

4.3.2 Modeling Warning and Error Messages

Discuss any warning and error messages present in the computer model output and the effects of such messages on the accuracy of the results.

4.4 Calibration

Provide a narrative discussion of hydrologic model calibration that was accomplished or attempted. This would include adjustment of model parameters to provide a closer correlation with physical runoff volumes and/or peak discharges of record for the study watershed.

4.5 Final Results

4.5.1 Hydrologic Analysis Results

Describe the results of the statistical or modeling efforts. Provide summary tables of results for each sub-basin modeled, at the locations necessary for proper floodplain delineation, and at other points of interest. The tables should include the following:

1. Peak discharge and time-to-peak for each recurrence interval storm analyzed,
2. Runoff volume for each recurrence interval storm analyzed,
3. Peak stage and inflow and outflow peak discharges for reservoir routing operations, and
4. Peak flow rates for each branch of a flow split or diversion.

4.5.2 Verification of Results

Discuss the reasonableness of the results. Describe comparisons of the results with indirect methods such as:

1. Other FIS studies in the area,
2. Gaged watershed data for similar watersheds, and
3. Indirect methods set forth in the Highway Drainage Design Manual, Hydrology, April 1994 by the Arizona Department of Transportation, including regression equations, envelope curves and other confidence checks.

Section 5: Hydraulics

5.1 Method Description

Describe the location and physical characteristics of the streams or washes for which floodplain limits are defined. Provide a narrative description of the water surface profile model used in the study. Include the model name, date/version, and source. Explain how the starting water surface elevations (WSEL) for the various streams are determined. Discuss any previous models or different versions of the model, if available.

5.2 Work Study Maps

Describe the work study floodplain maps prepared as part of the TSDN. Discuss the nomenclature used in preparation of the maps. Explain how the streams and washes are divided into reaches based on changes in peak discharge and roughness coefficients or similar criteria such as split flow locations. Provide a report figure which is a general overview map of the study area. The floodplain delineation reaches and key features of the study area are to be identified on the map. The figure is to be no smaller than 11" x 17" and drawn to scale. Provide reduced scale work study maps no smaller than 11" x 17" in the report volume, in addition to full scale work study maps. All maps must have a graphic scale bar. Refer to Section VI of this document for required information to be placed on all maps and exhibits.

5.3 Parameter Estimation

5.3.1 Roughness Coefficients

Document the source or method of estimating the channel roughness coefficients, such as Manning's n-values. Include photographs of appropriate stream reaches. Provide a summary table of the selected coefficients organized by reach.

5.3.2 Expansion and Contraction Coefficients

Document the source or method used to estimate expansion and contraction coefficients. Describe the physical characteristics of the stream and obstructions to flow that require changes in coefficients from the norm.

5.4 Cross Section Description

Provide a narrative discussion of the placement of cross sections and the cross section orientation. Describe how the cross sections are obtained.

5.5 Modeling Considerations

5.5.1 Hydraulic Jump and Drop Analysis

Describe locations where a hydraulically significant hydraulic jump or drop may be expected to occur. State how the floodplain limits are adjusted, if at all, to account for these phenomena.

5.5.2 Bridges and Culverts

Provide a narrative discussion of the methods used to model bridges and culverts. Describe any assumptions made in the analyses. Provide a summary table listing the location of each structure, a description of the type of structure, and the method used to model it. List any as-built drawings available (with date of preparation and year of construction, if known) for each structure or state that as-built dimensions are obtained by field survey. The as-built and survey data documentation shall be referenced to the appropriate TSDN appendix.

5.5.3 Levees and Dikes

Describe the location, extent, and physical characteristics of hydraulically significant levees or dikes present along the study streams or washes. Provide a narrative discussion of the methods used to model the effects of these structures. Document the results and freeboard provided by the levee from the hydraulic analysis. Discuss and provide all available supporting documentation for the levee or dike. List any as-built drawings available (with date of preparation and year of construction, if known) for each structure or state that as-built dimensions are obtained by field survey. Supporting documentation may include but is not limited to the following: geotechnical reports, structural analyses, interior drainage analyses, inspections reports, operation and maintenance plans, owner / operator information, or previous certification. Please reference 44 CFR, Section 65.10 and FEMA Procedural Memorandums 32, 34, 43, 51, 52, 53, 63 and 64 for additional guidance regarding levee accreditation requests. Study preparers are also encouraged to visit the FEMA website for current guidance that may be applicable to levee accreditation requests.

5.5.4 Non-Levee Embankments

Non-levee embankments, defined by FEMA in Procedural Memorandum 51 are embankments that were not designed or constructed as flood control structures such as those for highways and railroads. These embankments are considered "non-certifiable" as providing protection against flooding downstream.

Describe the location, extent, and physical characteristics of hydraulically significant non-levee embankments. Provide a narrative discussion of the methods used to model the effects of these structures and demonstrate how the embankment impacts the flooding in the vicinity of the structure. If applicable to show the worst-case flooding scenario, discuss and document the "with non-certifiable levee" and "without non-certifiable levee" conditions and/or other scenarios modeled.

5.5.5 Islands and Flow Splits

Describe the location, extent, and physical characteristics of hydraulically significant islands or flow splits present along the study streams or reaches. Provide a narrative description of how the effects of these areas are in the models. List any assumptions made such as mapping over smaller features with respect to a more conservative flood hazard identification approach.

5.5.6 Ineffective Flow Areas

Describe the location, extent, and physical characteristics of hydraulically ineffective flow areas present along the study streams or reaches. Provide a narrative description of how the effects of these areas are modeled. List any assumptions made.

5.5.7 Supercritical Flow

List and describe reaches of supercritical flow in each stream or wash as set forth in ADWR State Standard 3.

5.6 Floodway Modeling

Provide a narrative discussion of the encroachment methods and procedures used to define floodway limits.

5.7 Issues Encountered During the Study

5.7.1 Special Issues and Solutions

Special issues are unique situations that are not addressed by the standard TSDN outline. Provide a narrative discussion of any special issues that were encountered during the study. Describe alternatives examined and the final solution used for each issue with references and documentation.

5.7.2 Modeling Warning and Error Messages

Discuss any warning and error messages present in the computer model output and the effects of such messages on the accuracy of the results.

5.8 Calibration

Provide a narrative description of any model calibration procedure attempted or accomplished.

5.9 Final Results

5.9.1 Hydraulic Analysis Results

Describe the results of the hydraulic modeling efforts. Provide summary tables of results for each stream or wash. The tables should include the following but not necessarily limited to:

Normal stream results:

1. Cross section identifier,
2. Peak discharge,
3 Water surface elevation,
4. Critical water surface elevation,
5. Average velocity,
6. Top width of flow,
7. Depth of flow,
8. Froude number, and
9. Left and right stations where water surface meets existing ground.

Bridge or culvert results for all cross sections defining the structure:

1. Cross section identifier,
2. Water surface elevation,
3. Energy grade line elevation,
4. Peak discharge,
5. Discharge through structure,
6. Discharge over weir,
7. Velocity head,
8. Friction loss, and
9. Contraction and expansion coefficients.

For studies that use HEC-RAS modeling, FEMA and/or the local government may require the submittal of CHECK-RAS output to verify that there are no serious modeling errors. This section should reference the appendix where this output is located.

5.9.2 Verification or Comparison of Results

Discuss the reasonableness of the results. Describe comparisons of the results with any previous studies. Discuss the comparison between the models, if available, such as the Pre-Project and Post Project Conditions Model.

Section 6: Erosion, Sediment Transport, and Geomorphic Analysis

6.1 Method Description

Describe the location and physical characteristics of the streams or washes for which erosion limits are estimated and/or sediment transport and/or geomorphic analyses are performed. Provide a narrative description of the methodologies and models used in the study. Include the model name, date, and source. Describe efforts to use historical data such as aerial photographs to establish the geomorphology of the river. List the dates and sources of aerial photographs and any other data sources used. Describe apparent changes to the channel alignment or geometry over time. Document whether those changes are due to natural processes, man-made obstructions or disturbances, or a combination of both.

6.2 Parameter Estimation

This section and any subsections should include a complete description of the methodology, sources, and calculations used to develop the parameters for erosion and sediment transport modeling and/or geomorphic analysis.

6.3 Modeling Considerations

Create subsections as necessary to describe the modeling considerations addressed during the study.

6.4 Issues Encountered During the Study

6.4.1 Special Issues and Solutions

Special issues are unique situations that are not addressed by the standard TSDN outline. Provide a narrative discussion of any special issues that were encountered during the study. Describe alternatives examined and the final solution used for each issue.

6.4.2 Modeling Warning and Error Messages

Discuss any warning and error messages present in the computer model output and the effects of such messages on the accuracy of the results.

6.5 Calibration

Provide a narrative description of any model calibration procedure attempted or accomplished.

6.6 Final Results

6.6.1 Erosion, Sediment Transport, and Geomorphic Analysis Results

Describe the results of the erosion, sediment transport, and geomorphic efforts. Provide summary tables of results for each stream or wash.

6.6.2 Verification of Results

Discuss the reasonableness of the results. Describe comparisons of the results with any previous studies.

Section 7: N/A

This section only applies to TSDNs submitted to FEMA

Appendix A: References

A.1 Data Collection Summary

Include a list of previous studies, other applicable studies, published and unpublished historical flood information, and research contacts.

A.2 Referenced Documents

Provide a list of all technical papers and documents pertaining to the methodology or unique parameters used in the study. Provide a copy of any paper or document critical to the analysis if there is any question of the reviewing agency having the referenced papers or documents.

Appendix B: General Documentation and Correspondence

B.1 General Project Documentation and Correspondence

Provide copies of correspondence documenting notification of the client and the methods of

addressing any special issues described in Sections 4.3, 5.7 and 6.4. Provide relevant meeting minutes and general correspondence.

B.2 Contract Documents
Provide a copy of the contract Scope of Work, not financial documents.

B.3 Public Notification
Provide a copy of any public notification used in conjunction with the study.

B.4 FEMA Correspondence
Provide any FEMA correspondence including review comments, if any.

Appendix C: Survey Field Notes

The field survey notes are to be clear and concise with appropriate sketches and notations. All field survey procedures and notes should meet requirements of State Board of Technical Registration and be sealed by a Registered Land Surveyor. Provide copies of the field survey notes organized per sections C.1 through C.4. Document the date of the last overall vertical control survey upon which the referenced benchmarks are based. Provide additional documentation verifying the accuracy of benchmarks located in areas of known subsidence.

C.1 Digital Projection Information
Coordinate System
Topo
GIS Files

C.2 Survey Field Notes For Aerial Mapping Control

C.3 Survey Field Notes For Hydrologic Modeling
Routing cross sections
Field reconnaissance notes for subbasin boundary verification and estimation of physical parameters
Structures

C.4 Survey Field Notes For Hydraulic Modeling
Cross sections
Structures
As-built drawings
ERM's

Appendix D: Hydrologic Analysis Supporting Documentation

D.1 Precipitation Data
Provide a copy of precipitation output or other calculations done to estimate precipitation frequency values described in Section 4.2.4 or 4.2.5.

D.2 Physical Parameter Calculations
Include detailed summaries of parameter calculations in spreadsheet or table format.

D.3 Hydrograph Routing Data
Include routing data, confidence checks on results, and cross section plots.

D.4 Reservoir Routing Data
Include hydraulic calculations and rating curve plots for control structures and volume calculations.

D.5 Flow Splits and Diversions Data
Include hydraulic calculations and rating curve plots used to define each flow split and diversion table.

D.6 Hydrologic Calculations
Include computer model input and output, logic diagrams, regression analysis, gage analysis, and any hand calculations.

Appendix E: Hydraulic Analysis Supporting Documentation

E.1 Roughness Coefficient Estimation
Include copies of photographs and calculations.

E.2 Cross Section Plots
Cross section plots to be provided unless not required by local government.

E.3 Expansion and Contraction Coefficients
Include any special data or calibration efforts made for estimation of expansion and contraction coefficients.

E.4 Analysis of Structures
Include any separate hydraulic modeling of structures used to estimate control data for floodplain delineation calculations.

E.5 Hydraulic Calculations
Include computer model output for floodplain and floodway hydraulic calculations.

Appendix F: Erosion, Sediment Transport, and Geomorphic Analysis Supporting Documentation

Include supporting documentation, parameter calculations, computer model output, and any other data and results prepared as a part of the analyses.

Exhibit Maps
Hydrology Watershed Maps
Hydrology Soils Maps
Hydrology land-Use Maps
Hydrology Logic Diagram
Hydraulics Work Study Map Index
Hydraulics Work Study Maps
Hydraulic Profiles
Erosion Setback Limit Maps
Geomorphic Maps
Two-Dimensional Mapping Outputs (Depth and Velocity)
Others as necessary or required by local government

IV. LOCAL GOVERNMENT ABSTRACT OUTLINE

SECTION 2 FOR SUBMITTALS TO LOCAL GOVERNMENTS

The complete Study Documentation Abstract (see abstract form in Appendix A) is to be provided as Section 2 and must contain the following information:

Section 1: Project Contact Information

1.1 Owner Contact Information: Provide mailing address, phone number, and e-mail.

1.2 Study Contractor Contact Information: Provide mailing address, phone number, and e-mail.

1.3 Local Technical Reviewer: Provide mailing address, phone number, and e-mail.

1.4 Date Study Submitted: Date study was submitted to the local government entity.

1.5 Date Review Comments Returned (if applicable): Date review comments were returned to study contractor.

1.6 Date Study Approved by Local Reviewing Agency: Date study approved by local government.

Section 2: General Information

Section 2.1: Project Location

2.1.1 Community: Provide community name.

2.1.2 County: County or counties where community is located.

2.1.3 River or Stream Name: Names of rivers, streams or watercourses analyzed in the documented study.

2.1.4 Reach Description: Description of the reaches of each river, stream or watercourse studied in documented report.

2.1.5 Study Type: Type of study completed on each river, stream or watercourse. This item is to clearly identify whether the study was riverine, alluvial fans, or other special hazard type study.

Section 2.2: Project Purposes and Summary of Findings

2.2.1 Purpose of the Study: Provide a brief description of the purpose of the study.

2.2.2 Summary of Hydrology and Hydraulic Methodologies Utilized: Provide a brief description of the hydrology and hydraulic methodologies used in the study.

2.2.3 Brief Summary Description of Study Results: Provide a brief description of the study results.

2.2.4 Acknowledgements: Provide any acknowledgements.

Section 3: Survey and Mapping Information

3.1 Digital Projection Information: Description of digital files provided including type/source, coordinate system, and the date of files.

3.2 USGS Quad Sheets: A list of map names and dates for the USGS 7.5' or 15' quadrangle maps of the study area. If available, other maps that better describe the study area can be referenced instead of the USGS quads if these maps are easily obtainable. Dates of maps and photography referenced should be included.

3.3 Mapping for Hydrologic Study: Description of maps used in the hydrologic portion of the study (if any) including type/source, scale, the dates of the maps, and the dates aerials were flown.

3.4 Mapping for Hydraulic Study: Description of maps used in the hydraulic portion of the study including type/source, scale, the dates of the maps, and the dates of aerial topography.

Section 4: Hydrology

4.1 Model or Method Used: Description of the hydrologic methodology or computer model used to estimate the peak flow rates used in the study. Description should include computer model vendor and version of model used.

4.2 Storm Duration: Indication of the storm duration used to estimate peak flow rate.

4.3 Hydrograph Type: Description of hydrograph type used in modeling.

4.4 Frequencies Determined: List of peak flow frequencies estimated in the hydrologic study (i.e., 10, 50, and 100-year, etc.).

4.5 List of Gages Used in Frequency Analysis or Calibration: List of gages used to calibrate the computer model or used in a statistical frequency computation. Information should include gage name, gage location, USGS number (if any), ownership, and years of record.

4.6 Rainfall Amounts and Reference: List rainfall amount(s), duration(s), aerial and temporal distribution(s) used for hydrologic modeling. Provide additional data and description in Section 4.2.5.

4.7 Unique Conditions and Issues: Description of any unique conditions or issues found during the study.

4.8 Coordination of Discharges: Description of process to coordinate peak flows with applicable agencies. Should include date, agency name, person contacted, and indication of agency concurrence or comments.

Section 5: Hydraulics

5.1 Model or Method Used: Description of hydraulic methodology or computer model used to determine flood elevations. Description should include computer model vendor and version of model used and any program modifications made by the contractor with supporting documentation.

5.2 Regime: Description of flow regime (i.e., subcritical, supercritical, mixed, etc.)

5.3 Frequencies for Which Profiles Were Computed: List of frequencies for which water surface elevations were calculated.

5.4 Method of Floodway Calculation: Description of method used to determine floodway (if any). This shall include explanation of any preliminary modeling results that indicate floodway analysis based on the Energy Grade Line surcharge instead of the Hydraulic Grade Line surcharge.

5.5 Unique Conditions and Issues: Description of any unique conditions or issues that impacted the study. This should include any hydraulic conditions such as jumps as well as any portion of the study where elevations were set, rather than computed by the computer model.

Section 6: Erosion, Sediment Transport, and Geomorphic Analysis

6.1 Summary of Method: Description of methodology or computer model(s) used to determine erosion, sediment transport, and geomorphic analysis. Description should include computer model vendor and version of model used and any program modifications made by the contractor with supporting documentation.

6.2 Issues Encountered During Study: Discuss any issues and how the issues were addressed.

6.3 Summary of Findings: Briefly discuss the erosion, sediment transport, and geomorphic analysis findings.

Section 7: Additional Study Information: Provide additional detail for any of the above sections.

V. TSDN OUTLINE FOR FEMA SUBMITTALS

The material contained within the TSDN will be organized as listed and described below. Sections that are not applicable should be denoted as such and are still contained in the TSDN. The numbering system should not be changed. Specific minimum standards are listed when appropriate.

The following is the detailed outline of the TSDN:

Title Page: The title page is to contain the name and location of the study, the name, address, phone number, and project number (or contract number) of the study requestor, the study preparer, and the date of preparation. The title page must include the professional registration seal of the study preparer. The title page shall also be titled "draft" if it is not in final form.

Table of Contents: The table of contents is to include a list of figures, a list of tables, a list of appendices, and the professional registration seal of the study preparer.

Section 1: Introduction

The introduction is to be structured to provide an overview of the material contained in the TSDN. The introduction should include the following and is to be organized at the discretion of the study preparer:

- Purpose of study (CLOMR, LOMR, new delineation, hydrology only or hydraulics only). Describe why a CLOMR or LOMR is necessary and the reasons for any revisions to hydrology or hydraulics.
- Authority for study (client name, contract number and date, project manager, etc).
- Location of study reach by section, township, range, community, and county. Provide a location map and vicinity map.
- Brief statement of methodology used for hydrology and hydraulics.
- Acknowledgments.
- Brief description of study results.

Section 2: FEMA Forms

FEMA Submittals - TSDN Section 2 is to contain the FEMA MT-2 forms for submittals to FEMA. The FEMA forms provide the main data, with TSDN Sections 3 through 7 and the Appendices used for overflow and additional information that cannot be placed within the form structure. Refer to the MT-2 Form Instructions for detailed information on the MT-2 forms.

Section 3: Survey and Mapping Information

3.1 Digital Projection Information

Provide a description of the electronic data available to the reviewer. This may include image files, GIS, or CAD files associated with the topo, aerial photos, or other supporting data. The coordinate system of the digital data should be discussed and metadata provided to document the source, date, and coordinate system of the data.

3.2 Field Survey Information

Provide a description of all survey information used in the study, including the dates when the survey work was performed. Document the professional responsible for field work, and the company name and project number if the work was completed by a sub-consultant. Provide a description of how the field notes in Appendix C are organized, and any other pertinent information necessary to understand the information in Appendix C. The information in Appendix C is to be sealed by a Land Surveyor registered in the State of Arizona.

3.3 Mapping

Provide a description of the mapping and map control used in the study. Provide a narrative overview identifying the mapping datum (both horizontal and vertical), date of the aerial photography, mapping scale, and contour interval. Document the date of the last overall vertical control survey upon which the referenced benchmarks are based. Provide additional documentation verifying the accuracy of benchmarks located in areas of known subsidence. Describe the flight path followed, the time-of-day photographs were taken, the number of stereo models used, and the photo scale. Distinguish between mapping used for hydrology and mapping used for hydraulics. Document the professional responsible for developing the mapping, and the company name and project number if the work was completed by a sub-consultant. Submittal of documentation to validate the topographic mapping accuracy through additional field survey may be required.

Section 4: Hydrology

4.1 Method Description

Provide a narrative description of the hydrologic methods or models used in the study. Include the model name, date, and source. Ensure that the hydrologic model or methodology chosen for the analysis is currently accepted by FEMA.

4.2 Parameter Estimation

This section and its subsections should include a complete description of the methodology and calculations used to develop the hydrology.

4.2.1 Drainage Area Boundaries

Describe the limits of the study watershed and the general watershed characteristics. Provide a general watershed map of the study area that is legible and to scale, showing the study area boundary, major sub-basin boundaries, and concentration points.

4.2.2 Watershed Work Maps

Describe the watershed work maps prepared as a part of the study and included as exhibit drawings. Discuss the nomenclature used to name subbasins, concentration points, routing reaches, reservoir routes, and flow diversions. Exhibits should be prepared covering the watershed, to scale, that depict the following, as a minimum:

1. Subbasin boundaries and concentration points,
2. Time-of-concentration or lag flow paths,
3. Hydrograph routing paths,
4. Soils boundaries, and
5. Land-use boundaries.

The exhibits are to be placed in pockets at the end of the TSDN, or bound under separate cover if too voluminous. Reduced copies of the exhibits are to be placed in this section if practical.

4.2.3 Gage Data

Identify and discuss locations of any National Weather Service (NWS), USGS, or other agency gage stations in or adjacent to the region and watershed in relation to historic precipitation, watershed runoff, and statistical parameters.

4.2.4 Statistical Parameters

Provide a narrative discussion of the data record and information available on precipitation, runoff and discharge for the region and the study watershed. Assess the adequacy and applicability of the record for use with Water Resources Council Bulletin 17B, (March 1982) or subsequent version. Discuss factors that may affect the reasonableness of frequency analysis for the study watershed and describe why or why not the methods in Bulletin 17B are used for estimating peak discharges for the study. Refer to Statistical Summaries of Streamflow Data and Characteristics of Drainage Basins for Selected Streamflow-Gaging Stations in Arizona Through Water Year 1996, USGS Water-Resources Investigations Report 98-4225 or subsequent version for state-wide data and results of Log-Pearson Type III analyses.

4.2.5 Precipitation

Provide further detail than described in Section 4.2.4. The additional detail should include a narrative discussion with supporting data of the historic precipitation records in or adjacent to the study watershed. Discuss the watershed size, the nature of historic flooding, the types of storms that result in flooding and the typical aerial extent of historic storms. Identify the rainfall duration and distribution pattern and the point rainfall values used for hydrologic modeling. Relate the hypothetical model design precipitation and distribution from stated reference sources to the historic record and statistical parameters.

4.2.6 Physical Parameters

Describe the methods used for estimation of the physical hydrologic parameters, such as rainfall losses, the unit hydrograph used, and time-of-concentration or lag. The discussion of rainfall losses should include the soils information used including the data source, surface retention losses, percent impervious estimates for natural and developed watersheds, and the effects of vegetation cover. Provide summary tables listing the physical parameters for every subbasin in the hydrologic models.

4.3 Issues Encountered During the Study

4.3.1 Special Issues and Solutions

Special issues are unique situations that are not addressed by the standard TSDN outline. Provide a narrative discussion of any special issues that were encountered during the study. Describe the alternatives examined and the final solution used for each issue. Examples may include burned watersheds, overgrazed areas, or non-default values.

4.3.2 Modeling Warning and Error Messages

Discuss any warning and error messages present in the computer model output and the effects of such messages on the accuracy of the results.

4.4 Calibration

Provide a narrative discussion of hydrologic model calibration that was accomplished or attempted. This would include adjustment of model parameters to provide a closer correlation with physical runoff volumes and/or peak discharges of record for the study watershed.

4.5 Final Results

4.5.1 Hydrologic Analysis Results

Describe the results of the statistical or modeling efforts. Provide summary tables of results for each sub-basin modeled, at the locations necessary for proper floodplain delineation, and at other points of interest. The tables should include the following:

1. Peak discharge and time-to-peak for each recurrence interval storm analyzed,
2. Runoff volume for each recurrence interval storm analyzed,
3. Peak stage and inflow and outflow peak discharges for reservoir routing operations, and
4. Peak flow rates for each branch of a flow split or diversion.

4.5.2 Verification of Results

Discuss the reasonableness of the results. Describe comparisons of the results with indirect methods such as:

1. Other FIS studies in the area,
2. Gaged watershed data for similar watersheds, and
3. Indirect methods set forth in the Highway Drainage Design Manual, Hydrology, April 1994 by the Arizona Department of Transportation, including regression equations, envelope curves and other confidence checks.

Section 5: Hydraulics

5.1 Method Description

Describe the location and physical characteristics of the streams or washes for which floodplain limits are defined. Provide a narrative description of the water surface profile model used in the study. Include the model name, date/version, and source. Explain how the starting water surface elevations (WSEL) for the various streams are determined. Discuss the models included such as existing FIS, Duplicate Effective Model, Corrected Effective Model, Existing or Pre-Project Conditions Model, and Revised or Post Project Conditions Model. Ensure that the hydraulic model or methodology chosen for the analysis is currently accepted by FEMA.

5.2 Work Study Maps

Describe the work study floodplain maps prepared as part of the TSDN. Discuss the nomenclature used in preparation of the maps. Explain how the streams and washes are divided into reaches based on changes in peak discharge and roughness coefficients or similar criteria such as split flow locations. Provide a report figure which is a general overview map of the study area. The floodplain delineation reaches and key features of the study area are to be identified on the map. The figure is to be no smaller than 11" x 17" and drawn to scale. Provide reduced scale work study maps no smaller than 11" x 17" in the report volume, in addition to full scale work study maps. All maps must have a graphic scale bar. Refer to Section VI of this document for required information to be placed on all maps and exhibits.

5.3 Parameter Estimation

5.3.1 Roughness Coefficients

Document the source or method of estimating the channel roughness coefficients, such as Manning's n-values. Include photographs of appropriate stream reaches. Provide a summary table of the selected coefficients organized by reach.

5.3.2 Expansion and Contraction Coefficients

Document the source or method used to estimate expansion and contraction coefficients. Describe the physical characteristics of the stream and obstructions to flow that require changes in coefficients from the norm.

5.4 Cross Section Description

Provide a narrative discussion of the placement of cross sections and the cross section orientation. Describe how the cross sections are obtained.

5.5 Modeling Considerations

5.5.1 Hydraulic Jump and Drop Analysis

Describe locations where a hydraulically significant hydraulic jump or drop may be expected to occur. State how the floodplain limits are adjusted, if at all, to account for these phenomena.

5.5.2 Bridges and Culverts

Provide a narrative discussion of the methods used to model bridges and culverts. Describe any assumptions made in the analyses. Provide a summary table listing the location of each structure, a description of the type of structure, and the method used to model it. List any as-built drawings available (with date of preparation and year of construction, if known) for each structure or state that as-built dimensions are obtained by field survey. The as-built and survey data documentation shall be referenced to the appropriate TSDN appendix.

5.5.3 Levees and Dikes

Describe the location, extent, and physical characteristics of hydraulically significant levees or dikes present along the study streams or washes. Provide a narrative discussion of the methods used to model the effects of these structures. Document the results and freeboard provided by the levee from the hydraulic analysis. Discuss and provide all available supporting documentation for the levee or dike. List any as-built drawings available (with date of preparation and year of construction, if known) for each structure or state that as-built dimensions are obtained by field survey. Supporting documentation may include but is not limited to the following: geotechnical reports, structural analyses, interior drainage analyses, inspections reports, operation and maintenance plans, owner / operator information, or previous certification. Please reference 44 CFR, Section 65.10 and FEMA Procedural Memorandums 32, 34, 43, 51, 52, 53, 63 and 64 for additional guidance regarding levee accreditation requests. Study preparers are also encouraged to visit the FEMA website for current guidance that may be applicable to levee accreditation requests.

5.5.4 Non-Levee Embankments

Non-levee embankments, defined by FEMA in Procedural Memorandum 51 are embankments that were not designed or constructed as flood control structures such as those for highways and railroads. These embankments are considered “non-certifiable” as providing protection against flooding downstream.

Describe the location, extent, and physical characteristics of hydraulically significant non-levee embankments. Provide a narrative discussion of the methods used to model the effects of these structures and demonstrate how the embankment impacts the flooding in the vicinity of the structure. If applicable to show the worst-case flooding scenario, discuss and document the “with non-certifiable levee” and “without non-certifiable levee” conditions and/or other scenarios modeled.

5.5.5 Islands and Flow Splits

Describe the location, extent, and physical characteristics of hydraulically significant islands or flow splits present along the study streams or reaches. Provide a narrative description of how the effects of these areas are in the models. List any assumptions made such as mapping over smaller features with respect to a more conservative flood hazard identification approach.

5.5.6 Ineffective Flow Areas

Describe the location, extent, and physical characteristics of hydraulically ineffective flow areas present along the study streams or reaches. Provide a narrative description of how the effects of these areas are modeled. List any assumptions made.

5.5.7 Supercritical Flow

List and describe reaches of supercritical flow in each stream or wash as set forth in ADWR State Standard 3. Ensure current FEMA regulations are followed relating to supercritical flow.

5.6 Floodway Modeling

Provide a narrative discussion of the encroachment methods and procedures used to define floodway limits.

5.7 Issues Encountered During the Study

5.7.1 Special Issues and Solutions

Special issues are unique situations that are not addressed by the standard TSDN outline. Provide a narrative discussion of any special issues that were encountered during the study. Describe alternatives examined and the final solution used for each issue with references and documentation.

5.7.2 Modeling Warning and Error Messages

Discuss any warning and error messages present in the computer model output and the effects of such messages on the accuracy of the results.

5.8 Calibration

Provide a narrative description of any model calibration procedure attempted or accomplished.

5.9 Final Results

5.9.1 Hydraulic Analysis Results

Describe the results of the hydraulic modeling efforts. Provide summary tables of results for each stream or wash. The tables should include the following but not necessarily limited to:

Normal stream results:

1. Cross section identifier,
2. Peak discharge,
3 Water surface elevation,
4. Critical water surface elevation,
5. Average velocity,
6. Top width of flow,
7. Depth of flow,
8. Froude number, and
9. Left and right stations where water surface meets existing ground.

Bridge or culvert results for all cross sections defining the structure:

1. Cross section identifier,
2. Water surface elevation,
3. Energy grade line elevation,
4. Peak discharge,
5. Discharge through structure,
6. Discharge over weir,
7. Velocity head,
8. Friction loss, and
9. Contraction and expansion coefficients.

For studies that use HEC-RAS modeling, FEMA and/or the local government may require the submittal of CHECK-RAS output to verify that there are no serious modeling errors. This section should reference the appendix where this output is located.

5.9.2 Verification or Comparison of Results

Discuss the reasonableness of the results. Describe comparisons of the results with any previous studies. Discuss the comparison between the models included such as existing FIS, Duplicate Effective Model, Corrected Effective Model, Existing or Pre-Project Conditions Model, and Revised or Post Project Conditions Model.

Section 6: Erosion, Sediment Transport, and Geomorphic Analysis

6.1 Method Description

Describe the location and physical characteristics of the streams or washes for which erosion limits are estimated and/or sediment transport and/or geomorphic analyses are performed. Provide a narrative description of the methodologies and models used in the study. Include the model name, date, and source. Describe efforts to use historical data such as aerial photographs to establish the geomorphology of the river. List the dates and sources of aerial photographs and any other data sources used. Describe apparent changes to the channel alignment or geometry over time. Document whether those changes are due to natural processes, man-made obstructions or disturbances, or a combination of both.

6.2 Parameter Estimation

This section and any subsections should include a complete description of the methodology, sources, and calculations used to develop the parameters for erosion and sediment transport modeling and/or geomorphic analysis.

6.3 Modeling Considerations

Create subsections as necessary to describe the modeling considerations addressed during the study.

6.4 Issues Encountered During the Study

6.4.1 Special Issues and Solutions

Special issues are unique situations that are not addressed by the standard TSDN outline. Provide a narrative discussion of any special issues that were encountered during the study. Describe alternatives examined and the final solution used for each issue.

6.4.2 Modeling Warning and Error Messages

Discuss any warning and error messages present in the computer model output and the effects of such messages on the accuracy of the results.

6.5 Calibration

Provide a narrative description of any model calibration procedure attempted or accomplished.

6.6 Final Results

6.6.1 Erosion, Sediment Transport, and Geomorphic Analysis Results

Describe the results of the erosion, sediment transport, and geomorphic efforts. Provide summary tables of results for each stream or wash.

6.6.2 Verification of Results

Discuss the reasonableness of the results. Describe comparisons of the results with any previous studies.

Section 7: Draft FIS Data

This section only applies to TSDNs submitted to FEMA.

7.1 Summary of Discharges

Provide a draft summary of discharges results table in FEMA format. If there is effective FIS data for the study area already, it should be the basis for revisions.

7.2 Floodway Data

Provide a draft floodway data results table in FEMA format.

7.3 Annotated Flood Insurance Rate Maps

Provide draft flood insurance rate maps according to the MT-2 Form Instructions.

7.4 Flood Profiles

Provide draft flood profiles in FEMA format. Electronic format export files such as dxf should be included.

Appendix A: References

A.1 Data Collection Summary

Include a list of previous studies, other applicable studies, published and unpublished historical flood information, and research contacts.

A.2 Referenced Documents

Provide a list of all technical papers and documents pertaining to the methodology or unique parameters used in the study. Provide a copy of any paper or document critical to the analysis if there is any question of the reviewing agency having the referenced papers or documents.

Appendix B: General Documentation and Correspondence

B.1 General Project Documentation and Correspondence

Provide copies of correspondence documenting notification of the client and the methods of addressing any special issues described in Sections 4.3, 5.7 and 6.4. Provide relevant meeting minutes and general correspondence.

B.2 Contract Documents

Provide a copy of the contract Scope of Work, not financial documents.

B.3 Public Notification

Provide a copy of any public notification used in conjunction with the study.

B.4 FEMA Correspondence

Provide any FEMA correspondence including review comments, if any.

Appendix C: Survey Field Notes

The field survey notes are to be clear and concise with appropriate sketches and notations. All field survey procedures and notes should meet requirements of State Board of Technical Registration and be sealed by a Registered Land Surveyor. Provide copies of the field survey notes organized per sections C.1 through C.4. Document the date of the last overall vertical control survey upon which the referenced benchmarks are based. Provide additional documentation verifying the accuracy of benchmarks located in areas of known subsidence.

C.1 Digital Projection Information

Coordinate System
Topo
GIS Files

C.2 Survey Field Notes For Aerial Mapping Control

C.3 Survey Field Notes For Hydrologic Modeling

Routing cross sections
Field reconnaissance notes for subbasin boundary verification and estimation of physical parameters
Structures

C.4 Survey Field Notes For Hydraulic Modeling

Cross sections
Structures
As-built drawings
ERM's

Appendix D: Hydrologic Analysis Supporting Documentation

D.1 Precipitation Data
Provide a copy of precipitation output or other calculations done to estimate precipitation frequency values described in Section 4.2.4 or 4.2.5.

D.2 Physical Parameter Calculations
Include detailed summaries of parameter calculations in spreadsheet or table format.

D.3 Hydrograph Routing Data
Include routing data, confidence checks on results, and cross section plots.

D.4 Reservoir Routing Data
Include hydraulic calculations and rating curve plots for control structures and volume calculations.

D.5 Flow Splits and Diversions Data
Include hydraulic calculations and rating curve plots used to define each flow split and diversion table.

D.6 Hydrologic Calculations
Include computer model input and output, logic diagrams, regression analysis, gage analysis, and any hand calculations.

Appendix E: Hydraulic Analysis Supporting Documentation

E.1 Roughness Coefficient Estimation
Include copies of photographs and calculations.

E.2 Cross Section Plots
Cross section plots to be provided unless not required by local government.

E.3 Expansion and Contraction Coefficients
Include any special data or calibration efforts made for estimation of expansion and contraction coefficients.

E.4 Analysis of Structures
Include any separate hydraulic modeling of structures used to estimate control data for floodplain delineation calculations.

E.5 Hydraulic Calculations
Include computer model output for floodplain and floodway hydraulic calculations.

Appendix F: Erosion, Sediment Transport, and Geomorphic Analysis Supporting Documentation

Include supporting documentation, parameter calculations, computer model output, and any other data and results prepared as a part of the analyses.

Exhibit Maps

Hydrology Watershed Maps
Hydrology Soils Maps
Hydrology Land-Use Maps
Hydrology Logic Diagram
Hydraulics Work Study Map Index
Hydraulics Work Study Maps
Hydraulic Profiles
Erosion Setback Limit Maps
Geomorphic Maps
Two-Dimensional Mapping Outputs (Depth and Velocity)
Others as necessary or required by local government

VI. GENERAL DOCUMENTATION STANDARDS

This section outlines general format standards for the material to be contained in the TSDN.

Appearance and Legibility
All materials contained in the TSDN must be legible and of an appearance that makes tracking and review possible. It is required that the material be typed. Technical analysis notes that describe the assumptions made in any analysis may be handwritten but must be clear and legible.

Size
Material in the TSDN should be 8.5" by 11". Material which is larger than standard size may be folded and included in the notebook or it may be rolled separately, clearly marked, and referenced in the TSDN. Reduced maps and drawings may be included provided a bar scale is legible after reduction.

Durability
The preferred materials for the TSDN should be selected to endure moderate to heavy use over long periods of time. Such materials can be three-ring binders that are slightly oversized (to reduce individual page stress), plastic sheaths, and pockets for electronic media and folded maps, heavy card stock divider pages for sections and appendices, etc.

Data Identification
Material included in the TSDN or attached separately will be marked with the following minimum information.

- Community name, county, and state.
- Date material prepared.
- Study contractor name and internal project number.
- Name of flooding sources.
- Appropriate documentation index number as outlined in Section III or V of these instructions.
- Whether the product is one of several.
- Any other relevant information that can assist users in identifying the data.

Exhibit Maps
All exhibit maps, included in the TSDN or attached separately, will be marked with the following information in addition to the information listed under DATA IDENTIFICATION:

- Index of maps *(8 .5" x 11" suggested size)*.
- Map bar scale.
- Source of base map and date including aerial mapping subcontractor, address, telephone number and internal project number, if applicable.
- Land Surveyor's seal and Engineer's seal with an appropriate certification and description of what each seal covers.
- North arrow.
- Names of streams, and major streets.
- Date flown (if aerial).
- Reference marks or known benchmarks. Maps should include section, township and range lines, and the location and datum of all points used for horizontal control. The maps should also include all bench marks used for vertical control, and the basis for the datum such as NAVD 1988 or local.

Electronic Deliverables

TSDNs shall be submitted in a PDF format on electronic medium acceptable to the submittal agency. Provide model and model results in original program format. Provide other supporting data such as topo, GIS, CAD files as required by the submittal agency.

Electronic deliverables will be denoted with the following information:

- Multiple-profile or single profile.
- Enough information for the reviewer to understand whether this run is the final run or a supplementary run, and to describe the intent in preparing the computer model.
- Hydraulic model printouts will be further annotated to show the applicable cross/section lettering used on the draft report text. Include comment records in the model to clearly identify road crossings, bridges, and key concentration points.

Computer models that are superseded by a more recent version of the model but contained in the TSDN for clarity of review will be marked "SUPERSEDED" or "VOID" in large letters.

Input data files of final runs of computerized hydraulic and hydrologic computations from standard programs such as HEC-1 or HEC-RAS will be submitted on compact disks, portables drive(s), or other media acceptable to the reviewing agency that meet the following specifications:

- An ASCII text file named "README" will be created for each disk or portable drive and will contain a description of each computer file on the disk or portable drive along with the information required under DATA IDENTIFICATION denoted under this section. A list of files along with the information required under DATA IDENTIFICATION will be placed on the media label.
- All computer files should be "read only".

Input and output from other types of computer compilations should be included under the appropriate index number and should clearly be identified by program name and source.

APPENDIX STUDY DOCUMENTATION ABSTRACT

The form on the following pages is to be used in Section 2 of the TSDN as described in Section IV.

Study Documentation Abstract for Local Government Submittals		
Section 1: Project Contact Information		
1.1	Owner Contact Information - Mailing Address - Phone Number - E -Mail	
1.2	Study Contractor Contact Information - Mailing Address - Phone Number - E -Mail	
1.3	Local Technical Reviewer - Mailing Address - Phone Number - E -Mail	
1.4	Date Study Submitted	
1.5	Date Review Comments Returned (if applicable)	
1.6	Date Study Approved by Local Reviewing Agency	
Section 2: General Information		
Section 2.1: Project Location		
2.1.1	Community	
2.1.2	County	
2.1.3	River or Stream Name	
2.1.4	Reach Description	
2.1.5	Study type (Riverine, Alluvial Fan, etc.)	
Section 2.2: Project Purposes and Summary of Findings		
2.2.1	Purpose of the Study	
2.2.2	Summary of Hydrology and Hydraulic Methodologies Utilized	
2.2.3	Brief Summary Description of the Study Results	
2.2.4	Acknowledgements	

Section 3: Survey and Mapping Information		
3.1	Digital Projection Information Type/Source Coordinate System Date	
3.2	USGS Quad Sheet(s) with original photo date & latest photo revision date. Current data may be substituted if available.	
3.3	Mapping for Hydrologic Study Type/Source Scale Date	
3.4	Mapping for Hydraulic Study Type/Source Scale Date Subcontractor (Aerial) Date of Aerial Mapping	
Section 4: Hydrology		
4.1	Model or Method Used (including vendor and version description)	
4.2	Storm Duration	
4.3	Hydrograph Type	
4.4	Frequencies Determined	
4.5	List of Gages Used in Frequency Analysis or Calibration (Location, Years of Record, Gage Ownership)	
4.6	Rainfall Amounts and Reference	
4.7	Unique Conditions and Issues	
4.8	Coordination of Discharges (Agency, Date, Comments)	

Section 5: Hydraulics		
5.1	Model or Method Used (including vendor and version description)	
5.2	Regime	
5.3	Frequencies for Which Profiles Were Computed	
5.4	Method of Floodway Calculation	
5.5	Unique Conditions and Issues	
Section 6: Erosion, Sediment Transport, and Geomorphic Analysis		
6.1	Summary of Method	
6.2	Issues Encountered During Study	
6.3	Summary of Findings	

Section 7: Additional Study Information	
Item	Description / Discussion