



# Technical Analysis Guide

Montana Department of Natural Resources and Conservation (DNRC)-  
Water Resources Division

## Overview

This guide identifies the technical analyses required for the water right permit and change process under the Administrative Rules of Montana (ARM) 36.12.1303 in support of the water rights criteria assessment as required in §§ 85-2-311 and -402, Montana Code Annotated (MCA). This guide contains a summary of the Department’s standard practices for each of the technical analyses, provides resources for an applicant completing their own technical analyses, and defines the processes by which the Department will evaluate the scientific credibility of applicant-supplied technical analyses.

This Technical Analysis Guide contains the following sections:

- Overview ..... 1
- Technical Analysis List ..... 3
  - 1. Surface Water Permit ..... 3
  - 2. Surface Water Change ..... 4
    - 2.a. Irrigation Water Right, Place of Use (POU) Change or Purpose Change ..... 4
    - 2.b. Mitigation Net Effect Analysis ..... 5
    - 2.c. Aquifer Recharge Monthly Accretion Analysis ..... 5
  - 3. Groundwater Permit ..... 5
    - 3.a. Closed Basin ..... 7
  - 4. Groundwater Change ..... 7
    - 4.a. Point of Diversion (POD) Change ..... 7
    - 4.b. Place of Use (POU) or Purpose Change ..... 8
    - 4.c. Irrigation Water Right, Place of Use (POU) or Purpose Change ..... 9
    - 4.d. Mitigation Net Effect Analysis ..... 10
    - 4.e. Aquifer Recharge Monthly Accretion Analysis ..... 10
- Technical Analyses Standard Practices ..... 11
  - Analysis of the Area of Potential Impact ..... 11
  - Analysis of the Area of Potential Impact of Depleted Surface Water ..... 11
  - Analysis of Impacted Surface Water Sources ..... 11



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Groundwater Technical Analyses .....	11
Historical Use Analysis .....	11
Return Flow Analysis .....	12
Surface Water Analysis.....	12
Surface Water Depletion Analysis.....	12
Region-Specific Practices .....	13
Scientific Credibility Review .....	14
Overview .....	14
Methodology .....	14
Quality of Analysis .....	14
Relevance of the Data Used .....	15



## Technical Analysis List

	Area of Potential Impact Analysis	Surface Water Analysis	Groundwater Analysis	Hydrogeologic Report	Analysis of Impacted Surface Water	Evaluation of Impacts to Identified Water Sources	Aquifer Recharge Purpose	Return Flow Analysis	Mitigation Net Effect Analysis	Groundwater Monthly Accretion Analysis	Surface Water Depletion Analysis	Surface Water Depletion Analysis for Permits	Analysis of Depleted Surface Water	Analysis of Depleted Surface Water	Groundwater Analysis for Changes
1. Permit: Surface Water	X	X													
2. Change: Surface Water			X	X											
2.a. Irrigation, POU or Purpose Change					X										
2.a.i. Water Rights Impacted by Change in Return Flow								X							
2.b. Mitigation Purpose									X						
2.c. Aquifer Recharge Purpose									X	X					
3. Permit: Groundwater											X	X	X	X	
3.a. Closed Basin															X
4. Change: Groundwater			X												
4.a. POD Change											X	X	X		X
4.b. POU Change											X	X	X		
4.c. Irrigation, POU or Purpose Change					X										
4.c.i. Water Rights Impacted by Change in Return Flow					X	X									
4.d. Mitigation Purpose								X							
4.e. Aquifer Recharge Purpose								X	X						

### 1. Surface Water Permit

A surface water Application for Beneficial Water Use Permit requires two technical analyses, a surface water analysis (ARM 36.12.1303(2)(a)) and an area of potential impact analysis (ARM 36.12.1303(2)(b)).

The **surface water analysis** is conducted pursuant to ARM 36.12.1702 and ARM 36.12.1303(2)(a). The analysis must include one of the following:

- (i) for perennial or intermittent streams where measurement records are available, the gage name, location, period of record, and calculated median of the mean monthly flow rate and volume;
- (ii) for perennial or intermittent streams where measurement records are not



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available, an estimated mean monthly flow rate and volume, and identify the estimation technique and basin characteristics used for the estimation;

(iii) for ephemeral streams, an explanation of the method used to calculate mean annual runoff and associated climate and drainage area data; and

(iv) for lakes, the source of the bathymetric data and associated volume or description of the method and associated data used to calculate volume;

The **area of potential impact analysis** must include a defined boundary for the area of potential impact and a list of all active and severed surface water rights within the boundary. During criteria assessment, the Department will create the legal demands index based on the area of potential impact analysis.

## 2. Surface Water Change

A surface water Application to Change an Existing Water Right requires a historical use analysis (ARM 36.12.1303(3)(a)) and an analysis of impacted surface water sources.

The **historical use analysis** is conducted pursuant to requirements in ARM 36.12.1902. The description of historical use information must be related to a date that is selected based on water right type (ARM 36.12.1902(1)). Historical use must be corroborated for elements defined in ARM 36.12.1902(7). Findings must include historical flow rate, historical diverted volume, and historical consumed volume, pursuant to requirements in ARM 36.12.1902(9) through ARM 36.12.1902(17).

An **analysis of impacted surface water sources** must include a defined boundary for the area of potential adverse effect and a list of all active and severed surface water rights within the boundary.

Additional Technical Analyses are required for specific situations. See below for the application scenarios which require additional analyses.

### 2.a. Irrigation Water Right, Place of Use (POU) Change or Purpose Change

A surface water Application to Change an Existing Water Right for an irrigation water right with a proposed place of use or purpose change, has an additional requirement of a **return flow analysis** of historical return flows and projected return flows for the amount of water being changed. This analysis must include:

- (i) amount of return flow;
- (ii) location of return flow; and
- (iii) if water rights are identified which will be impacted by a change in return flow, the return flow analysis must include a monthly breakdown of the rate and timing of return flow and evaluate impacts to the identified rights.



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An analysis of the monthly rate and timing of return flows is required when the following conditions are NOT met:

- Return flows will enter back into the source where they have historically returned upstream of or at the location of the next downstream appropriator; or,
- Water is left instream so historically diverted flows are available during the historic period of diversion either below the point of diversion or where return flows historically returned to the source.

### 2.a.i. Water Rights Impacted by Change in Return Flow

An extended return flow analysis which includes an **evaluation of impacts to the identified water rights** is an additional requirement of the return flow analysis when a monthly breakdown of the rate and timing of return flow is conducted because water rights are identified which will be impacted by a change in return flow. The evaluation of impacts to identified water rights must include a defined boundary for the area of potential impact and a list of all active and severed surface water rights within the boundary. To analyze the adverse effect criterion when there is a change to the location or amount of return flows, an extended analysis of physical availability and legal demands on the source is necessary. During criteria assessment, the Department will create the legal demands index based on the area of potential impact analysis.

### 2.b. Mitigation Net Effect Analysis

A surface water Application to Change an Existing Water Right that proposes a mitigation purpose has an additional requirement of an **analysis of the net effect to hydraulically connected surface water(s)**. The goal of this analysis is to see if water proposed for a mitigation purpose fully replaces the water not legally available for lost return flows or new net depletions, to ensure there is no negative net effect.

### 2.c. Aquifer Recharge Monthly Accretion Analysis

Surface water Applications to Change an Existing Water Right where aquifer recharge is proposed for mitigation have additional requirements of an analysis of the monthly accretions to hydraulically connected surface water(s) and an analysis of the net effect to hydraulically connected surface water(s). The **analysis of the monthly accretions to hydraulically connected surface water(s)** determines the amount of water that accretes to hydraulically connected surface water(s) because of aquifer recharge. The **analysis of the net effect to hydraulically connected surface water(s)** determines if this water fully replaces the water not legally available for lost return flows or new net depletions, to ensure there is no negative net effect.

## 3. Groundwater Permit

A groundwater Application for Beneficial Water Use Permit requires a groundwater analysis, surface water depletion analysis, surface water analysis of depleted surface water, and area of potential impact analysis of depleted surface water.



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The **groundwater analysis for permits** is conducted pursuant to ARM 36.12.1703 and must include:

- (i) aquifer transmissivity and storage coefficient;
- (ii) maximum drawdown and remaining available water column in the proposed point of diversion(s);
- (iii) 0.01-foot drawdown contour;
- (iv) location and distance between the proposed point of diversion(s) and the 0.01-foot drawdown contour;
- (v) annual groundwater flux through the 0.01-foot drawdown contour, annual groundwater recharge, or annual groundwater discharge. The quantification must be in acre-feet per year; and
- (vi) all groundwater rights with points of diversion within the 0.01-foot drawdown contour or area of potential impact;
- (vii) 1-foot drawdown contour, which is based on five years of constant pumping, which is derived from the requested annual volume and apportioned monthly based on the proposed period of diversion;
- (viii) distance and location on a map between the proposed point of diversion(s) and the 1-foot drawdown contour;
- (ix) all groundwater rights within the 1-foot drawdown contour; and
- (x) remaining available water column for each groundwater point of diversion identified in (ix);

*Groundwater Analysis Tip:* To generate a list of groundwater rights within the 0.01-foot and 1-foot drawdown contour, include active and severed rights and only filter by well depth, if source aquifer is not hydrologically connected to another hydrologic unit, formation, or geologic structure because of a distinct and continuous confining unit.

The **surface water depletion analysis** must include:

- (i) hydraulically connected surface water(s) to the source aquifer for the proposed point of diversion; and
- (ii) annual consumed volume and monthly rate and volume of net depletion to hydraulically connected surface water(s);

The **surface water analysis of depleted surface water** must include:

- (i) for perennial or intermittent streams where measurement records are available, the gage name, location, period of record, and calculated median of the mean monthly flow rate and volume;
- (ii) for perennial or intermittent streams where measurement records are not available, an estimated mean monthly flow rate and volume, and identify the estimation technique and basin characteristics used for the estimate;
- (iii) for ephemeral streams, an explanation of the method used to calculate mean annual runoff and associated climate and drainage area data; and
- (iv) for lakes, the source of the bathymetric data and associated volume or



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description of the method and associated data used to calculate volume;

The **area of potential impact analysis** must include a defined boundary for the area of potential impact for any depleted surface water source and a list of all active and severed surface water rights within the boundary.

Additional Technical Analyses are required for specific situations. See below for the application scenarios which require additional analyses.

### 3.a. Closed Basin

A groundwater Application for Beneficial Water Use Permit in a closed basin includes an additional requirement of a **hydrogeologic report**, pursuant to §85-2-361, MCA. *In order to satisfy § 85-2-360, MCA, applicants for groundwater permits in closed basins MUST have a preapplication meeting if they want the Department to conduct the technical analyses, including the hydrogeologic report. If they do not have a preapplication meeting, they must conduct their own technical analyses.*

## 4. Groundwater Change

A groundwater Application to Change an Existing Water Right requires a historical use analysis (ARM 36.12.1303(3)(a)).

The **historical use analysis** is conducted pursuant to requirements in ARM 36.12.1902. The description of historical use information must be related to a date that is selected based on water right type (ARM 36.12.1902(1)). Historical use must be corroborated for elements defined in ARM 36.12.1902(7). Findings must include historical flow rate, historical diverted volume and historical consumed volume, pursuant to requirements in ARM 36.12.1902(9) through ARM 36.12.1902(17).

Additional Technical Analyses are required for specific situations. See below for the application scenarios which require additional analyses.

### 4.a. Point of Diversion (POD) Change

A groundwater Application to Change an Existing Water Right with a proposed point of diversion change includes the additional requirements of a groundwater analysis and surface water depletion analysis if the proposed change will lead to a change in consumptive use or pumping schedule.

The **groundwater analysis** must include:

- (i) aquifer transmissivity and storage coefficient;
- (ii) maximum drawdown and remaining available water column in the proposed point of diversion(s);
- (iii) 1-foot drawdown contour, which is based on five years of constant



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- pumping, which is derived from the requested annual volume and apportioned monthly based on the proposed period of diversion;
- (iv) the distance and location on a map between the proposed point of diversion(s) and the 1-foot drawdown contour;
  - (v) all groundwater rights within the 1-foot drawdown contour; and
  - (vi) remaining available water column for each groundwater point of diversion identified in (v);

*Groundwater Analysis Tip:* To generate a list of groundwater rights within the 0.01-foot and 1-foot drawdown contour, include active and severed rights and only filter by well depth, if source aquifer is not hydrologically connected to another hydrologic unit, formation, or geologic structure because of a distinct and continuous confining unit.

The **surface water depletion analysis** must include:

- (i) all hydraulically connected surface water(s) to the source aquifer for the proposed point of diversion; and
- (ii) historic and proposed annual consumed volumes and monthly rate and volume of net depletion to hydraulically connected surface water(s); and
- (iii) a comparison of the historical net depletion and new net depletion to hydraulically connected surface water(s)

If the proposed change will cause the source, location, volume, or timing of net depletions to change compared to historical net depletions, then the application must evaluate adverse effect to surface water rights on the depleted surface water source(s). This evaluation is necessary to meet the Adverse Effect criterion, and can be included in the Technical Analysis via designation by the applicant to provide information regarding the “extended surface water depletion analysis”.

The extended surface water depletion analysis includes:

- definition of a boundary for the area of potential adverse effect on the hydraulically connected surface water source(s) and a list of all active and severed surface water rights within the boundary, and
- analysis of physical availability of the hydraulically connected surface water source(s) within the area of potential adverse effect.

#### 4.b. Place of Use (POU) or Purpose Change

A groundwater Application to Change an Existing Water Right with a proposed place of use or purpose change includes the additional requirement of a surface water depletion analysis if the proposed change will lead to a change in consumptive use or pumping schedule.

The **surface water depletion analysis** must include:

- (i) all hydraulically connected surface water(s) to the source aquifer for the proposed point of diversion; and
- (ii) historic and proposed annual consumed volumes and monthly rate and volume of net depletion to hydraulically connected surface water(s); and





(iii) a comparison of the historical net depletion and new net depletion to hydraulically connected surface water(s)

If the proposed change will cause the source, location, volume, or timing of net depletions to change compared to historical net depletions, then the application must evaluate adverse effect to surface water rights on the depleted surface water source(s). This evaluation is necessary to meet the Adverse Effect criterion, and can be included in the Technical Analysis via designation by the applicant to provide information regarding the “extended surface water depletion analysis”. The extended surface water depletion analysis includes:

- definition of a boundary for the area of potential adverse effect on the hydraulically connected surface water source(s) and a list of all active and severed surface water rights within the boundary, and
- analysis of physical availability of the hydraulically connected surface water source(s) within the area of potential adverse effect.

#### 4.c. Irrigation Water Right, Place of Use (POU) or Purpose Change

A Groundwater Application to Change an Existing Water Right for an irrigation water right with a proposed place of use or purpose change, includes the additional requirement of a return flow analysis of historical return flows and projected return flows for the amount of water being changed.

The **return flow analysis** must include:

- (i) amount of return flow;
- (ii) location of return flow; and
- (iii) if water rights are identified which will be impacted by a change in return flow, the return flow analysis must include a monthly breakdown of the rate and timing of return flow and evaluate impacts to the identified rights.

An analysis of the monthly rate and timing of return flows is required when the following conditions are NOT met:

- Return flows will enter back into the source where they have historically returned upstream of or at the location of the next downstream appropriator; or,
- Water is left instream so historically diverted flows are available during the historic period of diversion either below the point of diversion or where return flows historically returned to the source.

#### 4.c.i. Water Rights Impacted by a Change in Return Flow

An extended return flow analysis which includes an **evaluation of impacts to the identified water rights** is an additional requirement of the return flow analysis when a monthly breakdown of the rate and timing of return flow is conducted because water rights are identified which will be impacted by a change in return flow. The **evaluation of impacts to identified water rights** must include a defined boundary for the area of potential impact and a list of all active and severed



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surface water rights within the boundary. To analyze the adverse effect criterion when there is a change to the location or amount of return flows, an extended analysis of physical availability and legal demands on the source is necessary. During criteria assessment, the Department will create the legal demands index based on the area of potential impact analysis.

#### 4.d. Mitigation Net Effect Analysis

A Groundwater Application to Change an Existing Water Right that proposes a mitigation purpose has an additional requirement of an **analysis of the net effect to hydraulically connected surface water(s)**. The goal of this analysis is to see if water proposed for a mitigation purpose fully replaces the water not legally available for lost return flows or new net depletions, to ensure there is no negative net effect.

#### 4.e. Aquifer Recharge Monthly Accretion Analysis

A Groundwater Application to Change an Existing Water Right where aquifer recharge is proposed for mitigation has the additional requirements of an **analysis of the monthly accretions to hydraulically connected surface water(s)** and an **analysis of the net effect to hydraulically connected surface water(s)**. The goals of these analyses are to determine the amount of water that accretes to hydraulically connected surface water(s) because of aquifer recharge and to see if this water fully replaces the water not legally available for lost return flows or new net depletions, to ensure there is no negative net effect.



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## Technical Analyses Standard Practices

The Department recommends that applicants completing their own Technical Analyses utilize the following resources. The Administrative Rules of Montana ([ARM](#)) can be found on the State of Montana Secretary of State website. The Permit and Change manuals and other Standard Practice documents can be found on the Department website on the Water Right Forms and Resources page.

### Analysis of the Area of Potential Impact

- ARM 36.12.1704: Permit Application- Legal Availability
- Permit Manual, Criteria Based Guidance- Legal Availability of Permits

### Analysis of the Area of Potential Impact of Depleted Surface Water

- ARM 36.12.1704: Permit Application- Legal Availability
- Permit Manual, Criteria Based Guidance- Legal Availability of Permits

### Analysis of Impacted Surface Water Sources

- ARM 36.12.1903: Change Application- Adverse Effect
- Change Manual, Criteria-Based Guidance- Adverse Effect for Changes

### Groundwater Technical Analyses

- ARM 36.12.1303(4)(a): Technical analyses- groundwater analyses for groundwater permit applications
- ARM 36.12.1303(5)(b): Technical analyses- groundwater analyses for groundwater change applications
- ARM 36.12.1703: Permit Application Criteria- Physical Groundwater Availability
- ARM 36.12.1706: Permit Application Criteria- Adverse Effect
- ARM 36.12.1903: Change Application- Adverse Effect
- Technical Standard Practices
  - Physical and Legal Availability of Groundwater Technical Memorandum, dated April 22, 2019
  - Numerical Groundwater Modeling Guidance Technical Memorandum, dated October 7, 2019

### Historical Use Analysis

- ARM 36.12.1902: Change Application- Historic Use
- Change Manual, Criteria-Based Guidance: Historical Use Section
- Technical Standard Practices
  - Technical Memorandum: Distributing Conveyance Loss on Multiple User Ditches



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## Return Flow Analysis

- ARM 36.12.1903: Change Application- Adverse Effect
- Change Manual, Criteria-Based Guidance- Adverse Effect for Changes
- Technical Standard Practices
  - Technical Memorandum: Calculating Return Flow (Levens, Goren, Zundel, Holmes, April 18, 2019)
- If an Evaluation of Impacts to Identified Water Rights is required:
  - Change Manual, Criteria-Based Guidance- Adverse Effect for Changes
  - Permit Manual, Criteria-Based Guidance- Physical Availability of Surface Water
  - Permit Manual, Criteria-Based Guidance- Legal Availability

## Surface Water Analysis

- ARM 36.12.1303(2)(a): Technical analyses- surface water analysis for surface water permit applications
- ARM 36.12.1303(4)(c): Technical analyses- surface water analysis of depleted surface water source(s) for groundwater permits
- ARM 36.12.1702: Permit Application Criteria: Physical Surface Water Availability
- Permit Manual, Criteria-Based Guidance- Physical Availability of Surface Water
- Technical Standard Practices
  - Technical Memorandum: Physical Availability of Surface Water with Gage Data (Elison, Mann, Dolan, Heffner, Brickl, November 1, 2019)
  - Technical Memorandum: Physical Availability of Ponds (Brickl, Roberts, Amman, Fiaschetti, April 22, 2109)
  - Technical Memorandum: Physical Availability of Surface Water Without Gage Data (Roberts, Brickl, Amman, Fiaschetti, April 18, 2019)
- Links to helpful resources
  - [USGS StreamStats Program](#)
  - [USGS – Current Conditions for Montana](#)
  - [Flow Measurement Calculator](#)

## Surface Water Depletion Analysis

- ARM 36.12.1303(4)(b): Technical analyses- surface water depletion analysis rule for groundwater permits
- ARM 36.12.1303(5)(c): Technical analyses- surface water depletion analysis rule for groundwater changes
- Technical Standard Practices
  - Net Surface Water Depletion from Ground Water Pumping Technical Memorandum, dated July 6, 2018
  - Surface Water Depletion for Regional Bedrock Aquifers Technical Memorandum, dated September 16, 2019



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## Region-Specific Practices

The Department may utilize the following Scientific Memos, in addition to Standard Practices, when addressing physical availability in the Flathead Valley, Missoula Valley, West Billings Area and Madison Aquifer.

- Legal Availability of Groundwater in the Flathead Deep Aquifer Memo, dated December 12, 2019
- Variance – Evergreen Aquifer Geothermal/Heat Exchange Wells (Flathead Valley), dated March 12, 2010
- Variance – Yellowstone River Terrace Level 3 Aquifer Properties Memo, dated March 1, 2022
- Variance – Missoula Valley Geothermal/Heat Exchange Wells Memo, dated March 10, 2010
- Madison Group Aquifer Memo, dated January 2, 2020



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## Scientific Credibility Review

### Overview

The scientific credibility review of technical analyses is performed by the Department if an applicant opts to perform their own technical analyses for an application. During the scientific credibility review, the Department analyzes the credibility of the methodology and results of each element of the technical analyses as required in ARM 36.12.1303 to determine if the applicant-submitted technical analyses are eligible to be used in the Department's criteria analysis. If the applicant opts to produce their own technical analyses, they must prove their methodology is scientifically substantial and credible. The Department has based its standards on best available science and legal precedence, and as such, considers its standards to be credible. The scientific credibility review will evaluate the **methodology**, **quality of the analysis**, and **relevance of the data** used for the technical analysis.

### Methodology

The methodology of technical analysis entails the procedures to collect data, models and equations used to analyze the data, and statistics and outputs employed to present findings. Describe the methodology you selected for all technical analyses with enough detail for the Department to assess your methodology using the following framing questions.

- The Department's standard methods are assumed to be scientifically credible if the inputs and calculations are correct.
- If the methods are not Department standard practices, then you must provide sufficient evidence to prove the methodology is credible, e.g., is the methodology used corroborated by scientifically credible publications or agencies?
- Is the methodology used pertinent to the specific application and analysis required? Consult relevant sections of the Administrative Rules of Montana and Montana Code Annotated to see if requirements exist for methodology. In particular, ARM 36.12.1303 requires specific statistics and outputs for numerous technical analyses.

### Quality of Analysis

The quality of technical analysis includes the accuracy, reliability, completeness, and validity of the manner with which the methodology was implemented and the conclusions were drawn. Provide the following, if applicable, with all technical analyses, so the Department can assess the quality of the technical analyses.

- Spreadsheets for all calculations, such as for historical use analysis or for deriving aquifer properties by hand.
- GIS shapefiles with the coordinate system noted, for all analyses with a geospatial component, including but not limited to the 0.01-ft and 1-ft drawdown contour, place of use, and area of potential impact.



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- Executable files or model files.
  - Input variables, such as: aquifer thickness, K, gradient, distance between wells or a well from a stream, pump schedules, and soil loss.
  - GWIC ID's, land surface elevation data, potentiometric or water table maps used to establish hydraulic connection between groundwater and surface water.
  - Description of the hydrogeologic setting near the project site and how it informed your selected methodology.
  - List of publications or referenced resources that support the analysis.

Examples of possible things the Department will consider when reviewing the quality of the analysis:

- Drawing a conclusion that is contradicted by the author's own statistical or qualitative evidence.
- Using a discredited method.
- Ignoring a process that is known to have a strong influence on the area under study.
- Basing analysis on insufficient data.
- Presenting unclear data tables.
- Implementing methodology incorrectly.
- Using contradictory data that either are not self-consistent or disagree with the conclusions.
- Using confirmatory data that adds little, if anything, to current understanding - unless strong arguments for such repetition are made.

## Relevance of the Data Used

The relevance of a technical analysis pertains to whether the conclusions of the analysis are reasonable given other examples in the project area and in applicable literature. The Department will use existing publications, established methods, maps and other resources to evaluate the relevance of technical analyses. Applicant-submitted technical analyses findings and conclusions need to be consistent with the evidence and arguments presented in other resources. If you submit technical analyses that disagree significantly with current academic or known science, you need to present a substantial case as to why your analyses are credible and relevant. The Department will address the following questions while evaluating the relevance of the technical analyses.

- Do methods and analyses address each required technical analysis?
- Do analyses make sense given the location of the project site, source type, and/or specifications of the proposed project?
- Are the data used in analyses and technical analyses reasonable when compared to existing published values or publications?
- Are there similarities and differences between the technical analyses and existing publications?