Chapter Forty-three
GENERAL TRAFFIC ENGINEERING STUDIES

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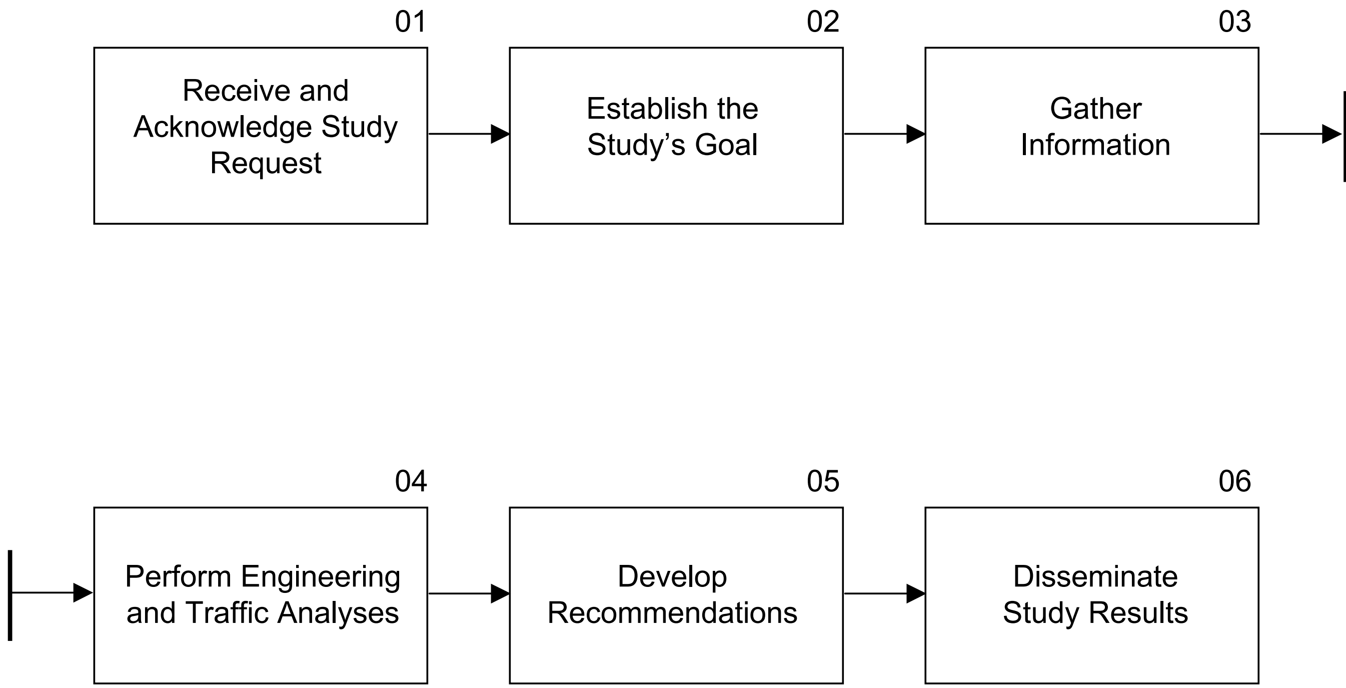
Chapter Forty-three
GENERAL TRAFFIC ENGINEERING STUDIES

Chapter Forty-three documents the Department's procedures for conducting general traffic engineering studies. It emphasizes the criteria that should be considered during each step of the analysis. A general traffic engineering study could consist of reviewing one or more of the different areas in the traffic engineering field. These areas could include signing, lighting, geometrics, signals, etc. The study could be assigned to any individual of the Department's traffic engineering staff. Because of this, Chapter Forty-three does not assign study responsibilities to a particular MDT Unit but rather to an individual within a Unit referred to in this Chapter as the investigator. Chapter Forty-three does not address technical details or analytical procedures as this information is documented elsewhere in the traffic engineering literature.

43.1 STUDY PROCEDURES

To facilitate consistency, Figure 43.1A presents a flowchart that illustrates the proper steps that should be followed during a general traffic engineering study. Following Figure 43.1A are brief descriptions of each activity within the flowchart. Adhering to these procedures will provide a consistent study approach.



GENERAL TRAFFIC ENGINEERING STUDY PROCEDURES

Figure 43.1A

GENERAL TRAFFIC ENGINEERING STUDY ACTIVITY

Activity Title: Receive and Acknowledge Study Request

Activity No.: 01

Responsibility: Investigator

Activity Description:

Requests will usually be via telephone call or letter to either a District Office or the Central Office. Requests typically arise from: concerns related to perceived problems with traffic operations; the preliminary scoping phase of pending construction projects; or a need to identify the scope of potential spot improvements. A copy of the request will be routed to both the District Administrator and the Traffic and Safety Engineer for informational purposes and to the Traffic Engineer for action.

The investigator, through the Traffic Engineer, will typically acknowledge the request by letter, if requested from an entity outside MDT, and send a copy to the appropriate District Administrator. At a minimum, the letter should:

1. acknowledge the receipt of the request
2. summarize the apparent concern, and
3. estimate the study's start date and duration when practical.

The letter may also indicate that a meeting is necessary. On a case-by-case basis, the Traffic Engineer may request such a meeting:

1. to better understand the apparent concern,
2. to address any specific issues or concerns of the requesting party, or
3. to discuss the anticipated procedures and analyses.

Section 2.2 provides the criteria for preparing general correspondence. If the investigation requires an initial meeting, a letter similar to Figure 40.5A in Chapter Forty may be considered.

GENERAL TRAFFIC ENGINEERING STUDY ACTIVITY

Activity Title:	Establish the Study's Goal
Activity No.:	02
Responsibility:	Investigator

Activity Description:

The purpose of this activity is to clearly identify the point-of-concern and establish the issues to be addressed by the study (i.e., the study's goal). The study should focus on and identify one or more of the following elements:

1. vehicular delay,
2. capacity/level of service,
3. parking,
4. geometrics,
5. crashes,
6. traffic control,
7. functional classification,
8. right-of-way,
9. access,
10. origin-destination, and
11. travel time

Upon completion of this activity, the investigator will have a clear understanding of the issues to address and of the traffic and environmental characteristics that are relevant to the study.

GENERAL TRAFFIC ENGINEERING STUDY ACTIVITY

Activity Title: Gather Information

Activity No.: 03

Responsibility: Investigator

Activity Description:

After the study's goal and its parameters have been established, the activity of gathering information relevant to conducting the traffic and engineering analyses begins. Relevant information may be categorized as follows:

1. site plan information,
2. type of traffic control,
3. traffic volume data,
4. traffic crash history,
5. travel speed profile, and
6. previous engineering and traffic investigations.

The first step is to gather and review previously documented information that is maintained by the Department as follows:

1. Montana Road Log,
2. current roadway plans,
3. photo log,
4. aerial photo file,
5. speed investigations,
6. pedestrian and/or school crossing studies,
7. traffic statistics file,
8. safety management system,
9. right-of-way information,
10. access studies, and
11. transportation planning documents (e.g., plans, improvements, letting dates).

The next step is to identify inadequacies in the existing information and to conduct any needed supplemental data collection activities.

GENERAL TRAFFIC ENGINEERING STUDY ACTIVITY

Activity Title: Perform Engineering and Traffic Analyses

Activity No.: 04

Responsibility: Investigator

Activity Description:

Upon receiving the information from Activity 03 (i.e., Gather Information), the investigator will:

1. review and evaluate the field observations;
2. process and refine the data into a form suitable for analysis;
3. analyze the data to define what, if any, deficiency exists;
4. revisit the site and collect additional information as necessary;
5. develop mitigation alternatives (e.g., traffic control, geometric changes);
6. compare the results to legal statutes, policies, and design criteria; and
7. identify the countermeasure best suited for the deficiency.

The result of the study's analyses is a clear set of conclusions relevant to the point-of-concern and the study's goal.

GENERAL TRAFFIC ENGINEERING STUDY ACTIVITY

Activity Title: Develop Recommendations

Activity No.: 05

Responsibility: Investigator

Activity Description:

The purpose of this activity is to formulate, from the study's conclusions, a specific recommendation or set of recommendations that will be presented to the concerned party and/or appropriate MDT entity. Interim draft recommendations may need to be developed and submitted to affected Departmental offices for review and comment.

GENERAL TRAFFIC ENGINEERING STUDY ACTIVITY

Activity Title:	Disseminate Study Results
Activity No.:	06
Responsibility:	Investigator

Activity Description:

The Traffic Engineering Section is responsible for distributing the study's results. The Traffic Engineering Section will coordinate with the District when the study's results are destined outside the Department. As necessary, the investigator will coordinate a local meeting with the District.

A report, documenting the conclusions, recommendations and all supportive information, will be submitted to the District and the requesting MDT entities. If the study's results are destined outside the Department, a copy of the report will also be sent to the outside requesting party. The report should be organized in one of the following two formats:

1. Short Report Format. A short report will be prepared as a memorandum and is typically used for those studies that are straightforward and relatively easy to understand.

2. Long Report Format. A long report will be prepared when a more comprehensive written presentation is necessary and will typically include the following components:

   a. title page,
   b. table of contents,
   c. abstract,
   d. introduction,
   e. report body,
   f. conclusions, and
   g. recommendations.

On a case-by-case basis, engineering judgment should be used in determining which report format is appropriate for the study. An oral presentation will also be given if requested by the local officials. The nature and focus of the recommendations will determine how corrective measures are implemented and who is responsible for implementation.

43.2 GATHERING INFORMATION

Upon receiving the study request and identifying the study's goal, the investigator will initiate the activity of gathering information. The activity's major focus is to better understand both existing and proposed conditions at the site and to reduce the possibility of collecting duplicate data. The relevancy and usefulness of existing data must be evaluated. Once the relevancy of existing information is established, the investigator can assess and identify the equipment and personnel requirements for obtaining additional data. This may include items such as special training, data forms, safety items, and special equipment (e.g., radar, stopwatches, cameras, video recorders). The following sections present the sources of information and the data that should be considered during the study.

43.2.1 Site Plan Information

An important part of any traffic engineering study is to develop an accurate site plan for the study. This will include gathering and summarizing information on adjacent topography, roadway geometric features, the functional intent of roadway(s), existing traffic control devices, and other information deemed relevant to the study. The following sections provide the investigator with guidance on gathering this information.

43.2.1.1 Road Log Information

Information pertaining to Federal-aid eligible roadways may be obtained from the booklet, Montana Road Log. This publication provides data relative to:

1. project numbers for as-built plans,
2. the year a roadway was built, and
3. the roadway's surfaced width.

The project number will provide the investigator with a useful index to roadway plans within the Department's records. Road log information will also inform the investigator of the age of the existing roadways and its general cross-sectional character.

43.2.1.2 Roadway Plans

As-built plans for the roadway or intersection under study should be obtained and reviewed. These plans contain geometric data (e.g., curb-to-curb widths, median widths) that may be needed for the study. They will also provide an excellent base plan for the site when developing alternative countermeasures if deficiencies are found. The plans can also be used to illustrate data collection locations, inventory data and other useful information.

43.2.1.3 Photo Log/Aerial Photo File

A search through the Department's photo log, digital photo log and aerial photo file should be conducted before the field investigation. These photographs help the investigator to:

1. review the study area before visiting the site,
2. examine potential data collection locations, and
3. identify key study elements and potential problems.

43.2.1.4 Traffic Control Devices Information

The Department's as-built plans should be researched for information on highway signing, pavement markings and traffic control devices that are within the study area. This information should be verified by comparing the data to field observations. The types and locations of any planned or programmed traffic control improvements should also be researched and included in the study.

43.2.1.5 Field Inventories

The extent of the inventory data required from the field depends on the scope of the study. The inventory data is needed to evaluate existing conditions and will provide the basis from which analyses of potential improvements can be performed. During the study, the investigator should consider the following field inventories:

1. Roadway Facilities Inventory. The field investigation should include an inventory of the roadway features that are within the study area. The following factors should be considered during this inventory:

    a. roadway classification (e.g., type of roadway);

    b. geometric data (e.g., cross-sectional, horizontal and vertical elements);

    c. number, direction and width of travel lanes;

    d. median type, width and adaptability as a pedestrian refuge;

    e. intersection geometry and approach lane designations;

f. approach density; and

g. location and cause of sight restrictions (e.g., parking, trees, buildings, vertical curves).

Section 43.3.2.3 provides additional information on sight distance analyses.

2. Pedestrian Facilities Inventory. An inventory of the facilities that are used by pedestrians should be compiled during the field investigation. The following factors should be considered for an inventory of pedestrian facilities:

a. existence and extent of pedestrian path networks and their relationship to the site;

b. type and width of pedestrian facilities (e.g., crosswalk);

c. location of pedestrian facilities (e.g., intersection, mid-block, commercial area);

d. width and condition of sidewalks, pathways and bike lanes;

e. quality and elevation of grade-separated structures (i.e., relative to road grade);

f. height and purpose of fencing, railing and barriers; and

g. presence of lighting and luminaires.

3. Traffic Control Devices Inventory. During the field investigation, an inventory of the existing traffic control devices within the study area should be made. The investigator should consider the following factors:

a. location, type, size and mounting height of traffic and pedestrian signs;

b. sign legend and operation (e.g., flashing beacons, variable message);

c. traffic signal location (e.g., intersection, mid-block);

d. traffic signal actuation, timing and phasing (e.g., fully actuated, exclusive phasing);

e. type, location and condition of pavement markings (e.g., striping, legends);

f. type and location of protective barriers (e.g., guardrails, median barriers);

g. regulatory speed limit, speed zone length and limit period (e.g., when flashing); and

h. parking location, restriction limits and practices (e.g., no standing).

43.2.1.6 Functional Classification

Planning documents (i.e., both urban or rural) should be researched to identify the functional classification of the roadway(s) in the study area. This will help the investigator to identify the functional purpose of each facility and to assess the relative importance of through-mobility and adjacent access.

43.2.2 Traffic Volume Data

The term "traffic volume" both quantifies the type of traffic flow and describes the function of the activity. The type of traffic flow can be subdivided into two basic categories, vehicular and pedestrian (i.e., non-motorized). Activity function is categorized as either movement through the facility or parking. The following sections provide information relative to the traffic volume data that should be considered during the study.

43.2.2.1 Vehicular Data

The traffic volume records that are maintained by the Department should be researched to determine the relevancy of existing vehicular data. This information will help determine if additional data is needed and will provide insight when conducting field observations. Both hourly and daily traffic volumes, as well as trends in monthly fluctuations, should be considered during the study. If the study includes a signal warrants analysis, a 24 hour directional machine count on each intersection approach and an 8 hour manual turning-movement count at the intersection will be necessary. The MUTCD and Chapter Twelve of the Traffic Engineering Manual provide additional information on conducting signal warrants analyses.

Historical vehicular data records obtained for the study should be verified with field observations. When assessing the vehicular data needs of the study and preparing for the field investigation, the investigator should consider the following factors:

1. observer location, collection purpose and method (e.g., pneumatic tubes, radar);
2. weather conditions and day of observation (e.g., workday, weekend);
3. major generators, seasonal variations and events (e.g., games, national parks);
4. locations of data collection (e.g., mid-block, intersection);

5. time period of collection (e.g., commuter peaks);
6. time interval data is collected (e.g., 15 minute);
7. vehicular direction (e.g., turning movement, through movement);
8. vehicular classification (e.g., passenger vehicles, large trucks, buses);
9. interval and distribution of gaps in vehicular stream;
10. presence and cause of vehicular platooning; and
11. vehicular approach speeds.

During the study, consideration should also be given to potential changes in vehicular volumes and travel patterns resulting from:

1. changes in existing land use (e.g., redevelopment, rezoning);
2. additional land development (e.g., platted and approved developments);
3. construction zones;
4. population growth changes;
5. addition of buses;
6. changes in other modes of public transportation; and
7. changes in jurisdictional boundaries (e.g., school attendance boundaries).

If it appears that such changes may impact the study area, then the investigator should consider generating the appropriate vehicular trips and assigning them to the local roadway network to assess the impact potential.

43.2.2.2 Pedestrian Data

Departmental records on pedestrian activity are generally limited. Nonetheless, historical pedestrian data should be researched for its relevancy. As needed, the investigator will collect pedestrian volume data and observe existing pedestrian habits and patterns at the site. When assessing the pedestrian data needs of the study and preparing for the field investigation, the investigator should consider the following factors:

1. purpose of data, collection method and location of observer;
2. weather conditions and day of observation (e.g., workday, weekend);
3. location of data collection (e.g., mid-block, intersection);
4. time period data is collected (e.g., commuter peaks);
5. time interval data is collected (e.g., 5 minute, 10 minute, 15 minute);
6. pedestrian volume data (e.g., total number, grouping, jaywalkers);
7. mix of pedestrians (e.g., workers, students, bicyclists);
8. age of pedestrians (e.g., young elementary students);
9. number of pedestrians, size of groups and number of rows;

10. major generators, seasonal variations and events (e.g., games, assemblies);
11. stature, mental capabilities, reaction time and walking speed of pedestrians;
12. accessibility requirements of pedestrians and the disabled (i.e., ADA);
13. potential vehicular and pedestrian conflicts; and
14. bus activity.

Figures 42.4A through 42.4F in Chapter Forty-two illustrate pedestrian data collection forms that are typically used by the Department.

43.2.2.3 Parking Data

The parking facilities that are available in the study area and their respective types of access can influence the traffic flow and safety potential along a roadway. The following are major issues relative to parking data that should be considered during the study:

1. on-street versus off-street parking facilities;
2. approach density;
3. traffic circulation patterns;
4. parking duration and turnover;
5. physical dimensions (e.g., stalls, width, access points);
6. State statutes and/or local ordinances;
7. traffic crash data (see Section 43.3.4); and
8. parking capacity and demand.

43.2.3 <u>Traffic Crash History</u>

It is important to research the Department's records on traffic crash data to identify the type and frequency of crashes that exist within the study area. This information will be useful when assessing crash patterns and probable causes and when formulating potential safety improvements if the study is focused on a crash-related problem. Information on highway crash history can be retrieved from the Department's Safety Management System. Additional documentation may be available from either the Montana Highway Patrol's central office or the area's local enforcement office. It should be noted that crash investigator's reports are confidential. The investigator should consider the following when researching this data:

1. collision types;
2. time of occurrence;
3. vehicular and/or pedestrian direction;
4. location of crashes;

5. crash frequency and patterns; and
6. any other contributing factors (e.g., vehicular type, environment, weather).

A collection of two to three years of crash statistics should be sufficient for the study; however, some studies may require analysis of a longer period. Section 43.3.4 provides additional information on traffic crash data and analyses.

43.2.4 Travel Speed Profile

An understanding of the travel speed profile on the section of roadway under study is necessary. Speed zone files that are maintained by the Traffic Investigations Unit contain valuable information on approved speed zones. The investigator should verify the date of the last investigation. If the site has undergone significant change, if substantial time has elapsed since the last data was collected or if there is simply insufficient data, then an existing speed profile should be obtained with the current study. The data collection process should follow the procedures that are discussed in Chapter Forty.

Once a basic understanding of the facility's existing running speed is developed, a design speed for the study must be established. This activity is accomplished by comparing the running speeds at the site with the roadway character approaching the site. Design speed through the site should be at least equal to the expectancy established by the approaching roadway and its surrounding environment. Design speed defines the level of functional capability expected of the site and is the datum used when evaluating existing site conditions.

43.2.5 Previous Engineering and Traffic Investigations

The Department may have conducted previous engineering and traffic investigations at the site or at other locations within the study area. If so, these records should be researched to determine if they are relevant to the current study.

43.3 ENGINEERING AND TRAFFIC ANALYSES

At this point in the study process, the investigator has identified the specific issues involved in the request, identified the scope and goal of the study and gathered pertinent information through both existing records and field collection. The next step is to conduct the engineering and traffic analyses that are relevant to study objectives. The purpose of such analyses is to evaluate the site and identify the extent to which existing function is meeting defined expectations. These analyses can focus on one specific function (e.g., pedestrian crossing, intersection) or be much broader in scope (e.g., a corridor study comprised of several coordinated analyses of operational elements). The following sections discuss the analyses that the investigator may find relevant to the study.

43.3.1 <u>Traffic Volume Analysis</u>

The purpose of a traffic volume analysis is to effectively describe the type and nature of travel demand at the site. This analysis is not usually conducted singularly. Rather, it is intended to accompany and support other analyses of the study. A traffic volume analysis should clearly describe the following items:

1. directional distribution of traffic on both an hourly and a daily basis (Note: Units of measure are typically either vehicles per hour or AADT.);
2. vehicular classification to identify functional demand;
3. monthly variations in travel demand to identify seasonal fluctuation;
4. historical yearly variations and short-term future projections;
5. long-range future planning projections;
6. destination (e.g., through-mobility, adjacent access);
7. general level of pedestrian activity;
8. significance of on-street parking turnover; and
9. relevance of mass transit and railroad elements.

43.3.2 <u>Analyses of Geometric Elements</u>

The physical geometry of the highway has a major influence on driver behavior. To promote safe and effective behavior, the geometric design of a highway should be consistent with driver expectancy, desire, capability, comfort and convenience. The investigator should evaluate the geometric elements of the site to ensure this objective by considering the following factors:

1. location,
2. alignment,
3. profile,
4. cross section,
5. intersections,
6. functional classification,
7. access and system control, and
8. aesthetics.

The investigator also should consider any special circumstances that may surface during the study, such as a site's proximity to an at-grade railroad crossing or a high percentage of trucks. For example, if the site is located in an industrial area, it will typically have a high percentage of truck traffic. Trucks generally:

1. require a greater turning radius (e.g., at intersections);
2. pose sight restrictions while in motion or while parked; and
3. require a greater distance to accelerate and decelerate.

The investigator should consider the impacts such circumstances may have on the study.

Lateral and longitudinal constraints (e.g., right-of-way, topography) are factors that significantly influence the feasibility of geometric modifications. The investigator should consider these factors when formulating the study's conclusions and recommendations.

An in-depth discussion on geometric design can be found in Part IV of the Traffic Engineering Manual and the AASHTO publications A Policy on Geometric Design of Highways and Streets and Roadside Design Guide. The following sections provide the investigator with additional guidance relative to conducting analyses of geometric elements.

43.3.2.1 Lane Configuration and Designation

The purpose of this analysis is to evaluate the adequacy of existing lane use. Lane use should be consistent with both the traffic patterns in the study area and with the capacity requirements of the roadway. Proper lane use should promote continuity of traffic flow, minimizing both interference and interruption. For example, the introduction of auxiliary lanes and lane reductions should be visible to the driver far enough in advance for adequate recognition and action.

43.3.2.2 Longitudinal and Cross-Sectional Elements

Desirably, highway alignment should be coordinated to ensure that changes in longitudinal elements (i.e., horizontal and vertical curvature) are adequately visible to the motorist for the facility's design speed. During the study, the investigator should evaluate highway alignment to ensure that driver expectancy is not violated and to identify the longitudinal elements that are either inconsistent with the facility's design speed or otherwise not adequately visible to the motorist.

The investigator should also evaluate the cross-sectional elements of the facility (i.e., those laterally dimensioned features within the highway right-of-way). Cross-sectional elements include:

1. width of travel lanes;
2. the existence, width and purpose of shoulders;
3. divisional medians and split alignments;
4. inslopes and back slopes;
5. drainage appurtenances;
6. utilities; and
7. other natural or man-made obstacles adjacent to the highway.

The two chief influences of cross-sectional elements are as follows:

1. <u>Flow Restriction</u>. Cross-sectional elements may present a restriction or friction to the flow of traffic. Items such as lane width, median type and lateral clearance are important considerations.

2. <u>Clear Zone</u>. A second influence is the extent to which the facility's roadside environment (e.g., lateral topography) is forgiving when a vehicle unintentionally leaves the highway. As such, it is important for the investigator to evaluate the clear-zone needs of the facility under study. The purpose of a clear-zone evaluation is to ensure that the existing roadside environment is consistent with the clear-zone needs of the facility. The area adjacent to the highway should be hazard-free and allow an errant vehicle to either successfully move back to the traveled way or come to a safe stop within the clear zone. If this objective cannot be achieved, then the hazard area may need to be shielded with a protective barrier. For additional information on roadside hazards, clear zones and protective barriers, the investigator is referred to Chapter Fourteen of the <u>MDT Road Design Manual</u> and the AASHTO publication <u>Roadside Design Guide</u>.

43.3.2.3 Sight Distance

A sight distance analysis is conducted to assess the adequacy of visibility along the roadway and may include the evaluation of:

1. intersection sight distance (e.g., at corners of intersections);
2. stopping sight distance (e.g., at sag and crest vertical curves);
3. passing sight distance (e.g., along rural roadways); and
4. decision sight distance.

The extent that highway features are visible to the motorist influences the functional potential of the entire facility. Design speed and driver expectancy are important considerations. During the study, the investigator should consider the following sight distance criteria:

1. Stopping Sight Distance. For the application of stopping sight distance criteria, See Chapter Twenty-four in Part IV of the Traffic Engineering Manual.

2. Sight Distance for No-Passing Zones. Chapter Nineteen in Part III of the Traffic Engineering Manual provides the investigator with information on the application of passing sight distance criteria associated with pavement markings, and Chapter Twenty-four in Part IV provides information relative to roadway design.

3. Intersection Sight Distance. Reference Chapter Twenty-eight in Part IV of the Traffic Engineering Manual for criteria relative to intersection sight distance.

4. Visibility to Signal Heads. If the study involves issues concerning the visibility of signal heads, the investigator should reference the applicable sections of Chapter Twelve in Part II of the Traffic Engineering Manual.

5. Sight Distance at Railroad Crossings. Reference Chapter Twenty-eight in Part IV of the Traffic Engineering Manual for criteria on sight distance at railroad crossings.

6. Sight Distance at Crosswalks. Criteria relative to sight distance at crosswalks is documented in Chapter Nineteen in Part III of the Traffic Engineering Manual.

7. Visibility of Consecutive Geometric Features. Reference Part IV of the Traffic Engineering Manual for the criteria on geometric design.

In addition, the investigator should consider factors that are typical of sight distance and vision obstruction analyses. These factors are as follows:

1. roadway geometrics;
2. location and nature of existing sight restrictions;
3. vehicular turning movements (e.g., dynamic sight obstructions);
4. vehicular approach speeds;
5. traffic volumes (e.g., through traffic, turning movements);
6. traffic crash data;
7. traffic conflicts;
8. sign placement;
9. billboard locations;
10. right-of-way locations;
11. pedestrian considerations;
12. environmental factors;
13. type and size of nearby developments; and
14. location and turnover of on-street parking.

43.3.2.4 Design Speed Consistency

An analysis of how design speed varies among the roadway's geometric elements will provide an understanding of the facility's operational consistency and its influence on driver expectancy. The investigator should consider evaluating design speed consistency in the following areas:

1. outside and immediately surrounding the study area,
2. through the study area itself, and
3. at transition locations between consecutive geometric elements.

43.3.2.5 Functional Classification/Access

The functional purpose of a roadway should be assessed in relationship to the environment it passes through. The investigator should evaluate the facility and compare the need for through-mobility against the need for direct access to adjacent development. The results of this analysis can significantly affect the study's conclusions and recommendations, especially if they are directly related to the geometric features of the facility.

43.3.3 Capacity Analysis

During the study, the investigator should consider the value of conducting a capacity analysis. A useful function of this analysis is to compare the existing travel demand to the functional potential of the facility. The level of service and the useful life of the facility are determined. When the desired level of service cannot be obtained by other improvements, geometric modifications to the facility may be necessary. This may include providing:

1. additional travel lanes,
2. auxiliary lanes,
3. passing lanes, and/or
4. truck climbing lanes.

The methods used to conduct capacity analyses are documented in the Highway Capacity Manual and Chapter Thirty of the Traffic Engineering Manual.

43.3.4 Traffic Crash Analysis

A traffic crash analysis involves determining the significance of crash history from summaries of crash characteristics. Such an analysis is necessary to identify probable safety deficiencies at the site. Traffic crash summaries quantify crash characteristics into statistical trends. These trends are used to identify statistically significant crash characteristics. The significant crash characteristics are then used to identify symptoms of a safety deficiency that may be subject to practical correction. The traffic crash analysis, when coordinated with other traffic and engineering analyses, contributes greatly to understanding operational problems at the site. However, it is important to note that a traffic crash analysis, by itself, only contributes to understanding the symptoms of a problem and not its cause.

During the study, the investigator should consider the following factors relative to traffic crash analyses:

1. Analysis Period. The data for the analysis should be retrieved from the most recent three-year crash history. If needed, a longer time period should be considered. The crash data should represent reasonably current information because traffic volumes, pavement condition and other site-related factors may vary with time. Care should be taken to ensure that past changes in the facility's character (e.g., physical changes, roadside development) are accounted for when evaluating the crash activity.

2. Site Boundary. The boundaries of analysis will vary with each study. The study area can be as small as a single intersection approach or a highway corridor.

3. Traffic Volume. Traffic volume is the number of vehicles traveling through the site during the analysis period. This may be either the total approach volume of an intersection or the two-way volume traversing a highway segment. Typically,

the data is initially gathered in the form of average annual daily traffic and then expanded to cover the analysis period.

4. Crash Rate. Crash rates are commonly expressed as the number of crashes per million vehicle miles for road sections and as the number of crashes per million entering vehicles for intersections. Crash rates are typically compared to statistics of statewide rates for facilities with similar characteristics. Crash rates are also used to compare different roadway design elements. The sample size needs to be sufficiently large to draw valid conclusions, and the analysis period needs to be long enough to uncover statistical trends (i.e., at least one year in urban areas and at least three years in rural areas). On a case-by-case basis, the investigator may conduct a more specialized analysis (e.g., seasonal or geographic variations). The investigator should verify that the study data is not biased. For example, a skewed analysis may result because a roadway was improved or a major development was built during the analysis period. As crash rates vary with time, the investigator must account for these anomalies.

5. Crash Summary. A crash summary quantifies the various crash characteristics and is used during the analysis to identify statistically significant trends in the data. The characteristics typically summarized in this process are as follows:

   a. number of crashes;
   b. location (e.g., intersection related, non-intersection related, specific point);
   c. crash type;
   d. movement intent (e.g., left turn versus through movement);
   e. vehicle direction;
   f. crash severity (e.g., fatality, injury, property damage);
   g. environmental factors (e.g., lighting, roadway conditions); and
   h. time of day.

   The crash data should be summarized in both tabular and graphical formats. Figure 43.3A illustrates a sample tabular format used to quantify the crash characteristics. Figure 43.3B presents a sample collision diagram used to graphically illustrate the crash data.

	Intersection	Non-Intersection Related	Other*
Angle			
Rear-End			
Single-Vehicle			
Side-Swipe			
Head-On			
Other**			

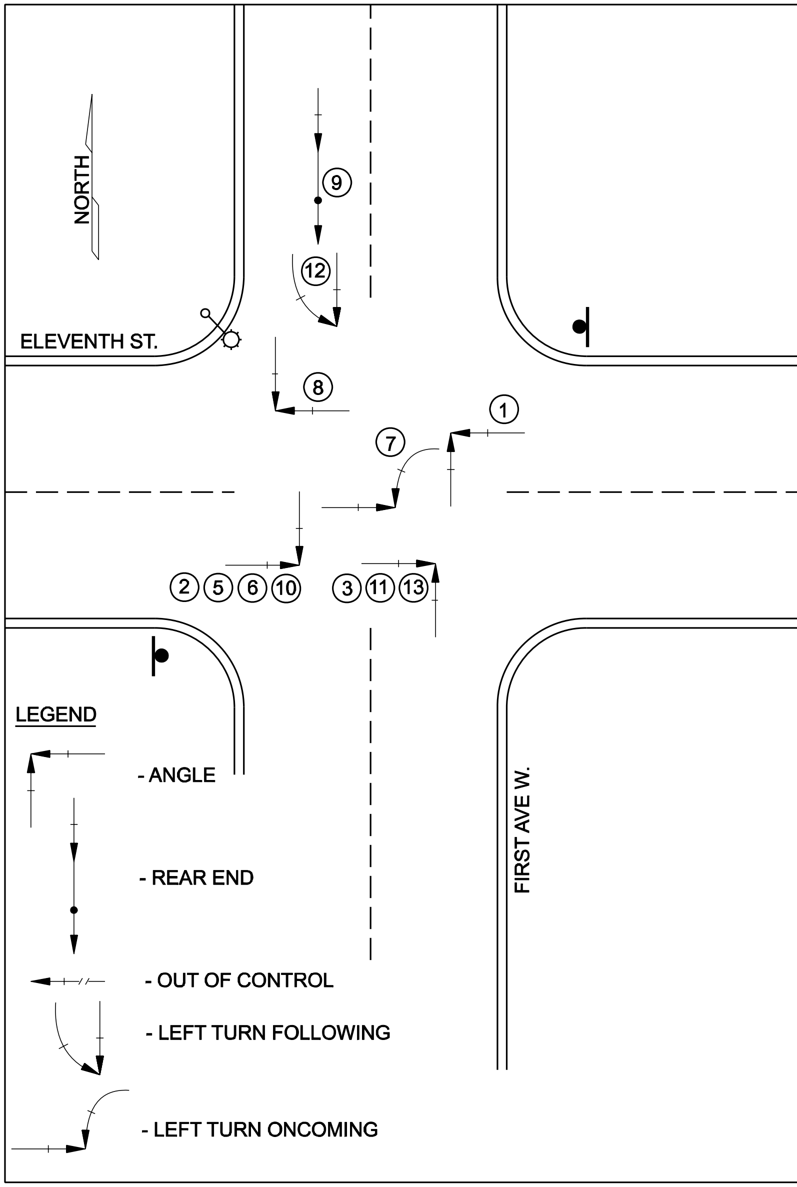
Notes:

* *Columns may be added as necessary for information relative to roadway surface condition, time-of-day, time-of-year, etc.*

** *Other tabular rows should be considered as necessary to accommodate various other types of collisions. The descriptor "other" should be used to tally those non-statistically significant collisions.*

SAMPLE CRASH DATA SUMMARY TABLE

Figure 43.3A



NO	REF. PT.	DATE	TIME	WEATHER	ROAD	LIGHT	SEV	ACC. TYP	REMARKS
1	283-303	7-27-93	1418	CLEAR	DRY	DAY	PD	ANGLE	
2	283-303	6-29-94	1040	CLEAR	DRY	DAY	PD	ANGLE	
3	283-303	6-22-94	0750	CLEAR	DRY	DAY	PD	ANGLE	SAME COLLISION
4	283-303	6-22-94	0750	CLEAR	DRY	DAY	PD	ANGLE	DIFFERENT NO.
5	283-303	11-10-94	1300	OVERCAST	DRY	DAY	PD	ANGLE	
6	283-303	1-23-94	0812	OVERCAST	DRY	DAY	INJ	ANGLE	
7	283-303	1-18-95	0835	SNOWING	WET	DAY	PD	ANGLE	
8	283-303	4-29-95	1525	CLEAR	DRY	DAY	PD	ANGLE	
9	283-303	5-11-95	1517	OVERCAST	DRY	DAY	INJ	RE	
10	283-303	5-23-95	0728	CLEAR	DRY	DAY	PD	ANGLE	
11	283-303	10-7-95	1146	CLEAR	DRY	DAY	PD	ANGLE	
12	283-303	11-11-95	1237	CLEAR	SLUSHY	DAY	PD	ANGLE	
13	283-303	11-27-95	1151	CLEAR	WET	DAY	INJ	ANGLE	
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COLLISION DIAGRAM AND DETAIL SHEET

LOCATION: ROUTE REF. PT. TO

DATA TIME PERIOD 7-1-93 TO 6-30-96

DRAWING BY ROD GWALTNEY DATE 11-8-96

CITY OF KALISPELL
INTERSECTION: 1ST AVE. W. AND 11TH ST.

SAMPLE COLLISION DIAGRAM

Figure 43-3B

6. Crash Analysis. Once the crash data has been compiled, the investigator must review the data to identify crash patterns and determine statistically significant trends. The severity patterns should also be examined to determine if a specific roadway or roadside feature may have contributed to the overall severity of the crashes. The results of this analysis should be coordinated with the rest of the study to determine causation.

7. Contributing Factors. The crash should also summarize the contributing circumstances. Contributing circumstances typically are categorized by:

   a. human (i.e., driver) factors;
   b. road condition factors;
   c. vehicle-related factors; and
   d. environmental factors.

   Environmental factors are typically located in the crash summary. The contributing circumstances typically verify, add or remove possible causes inferred by the crash summary. In addition, the contributing circumstances information can be used to identify crashes that are not related to roadway operation.

43.3.5 Intersection Traffic Control Analyses

The purpose of intersection traffic control is to assign right-of-way priority within an intersection. Analyses are routinely conducted to assess the controlled intersection's effectiveness under prevailing or changing traffic conditions. When conducting such analyses, the investigator should evaluate the relative benefits of each alternative developed to mitigate operational or safety deficiencies at the intersection. Intersection travel demand, traffic control and geometrics must be coordinated during the study. The following sections provide the investigator with additional information relative to intersection traffic control analyses.

43.3.5.1 Stop and Yield Control

According to Sections 61-8-341, 61-8-342 and 61-8-344 of the Montana Code Annotated, a minor street that intersects a major collector, or greater functional class facility, is provided stop control unless an engineering analysis determines the need for an alternative control measure. In cases where two intersecting roadways are identical in functional class, an engineering analysis is required. A request for a stop and yield control analysis can also originate from:

1. roadway reconstruction projects,
2. changes in traffic patterns,
3. operational complaints,
4. crash trends, or
5. other similar reasons.

The investigator must gain an understanding of the operational needs of the intersection under study. This may include evaluating:

1. the relationship between through-mobility on the major roadway and the demand for access from the side street;

2. the relative balance in the volume of traffic between the two roadways;

3. the relationship between right-of-way priority assigned to conflicting traffic movements; and

4. the relative balance of traffic volume between individual vehicular movements.

The results of this analysis will help the investigator to assess the adequacy of existing traffic control at the intersection and to determine the need to provide, for example:

1. yield control, if adequate sight distance exists;
2. multi-way stop control;
3. supplemental warning devices; or
4. a traffic signal.

The investigator should consider the following factors when conducting a stop and yield control analysis:

1. vehicular volumes and turning movements,
2. intersection sight distance,
3. roadway geometrics,
4. vehicular approach speeds,
5. available capacity,
6. traffic crash data,
7. traffic conflicts,
8. drivers' compliance with signing, and
9. sign placement.

During the analysis, the investigator should also consider the criteria that is documented in the following publications:

1. Montana Code Annotated;

2. A Policy on Geometric Design of Highways and Streets, AASHTO;

3. Manual of Uniform Traffic Control Devices, FHWA, ATSSA, AASHTO and ITE; and

4. Chapter Eighteen of the Traffic Engineering Manual.

43.3.5.2 Traffic Signal Control

A key objective of a traffic signal control analysis is to assess how effective the vehicular right-of-way is being assigned in relationship to the prevailing conditions at the intersection. There are two possible forms of a traffic signal control analysis that may be necessary for the study. The investigator may either:

1. evaluate changing the intersection's traffic control from passive stop or yield control to active traffic signal control; or

2. analyze the impacts of altering the intersection's traffic signal operation.

During the analysis, the investigator should consider the factors presented in Section 43.3.5.1 and evaluate the intersection's traffic control based on the number and location of vehicular stops and the amount of vehicular delay that is experienced by individual traffic movements. In addition, the investigator should consider the purpose of each intersecting roadway and strive to maintain each roadway's functional class while balancing stopped vehicles and vehicular delay at the intersection. The major roadways of the transportation system (i.e., with a functional class of major collector and higher) are under the jurisdiction of the Department. As such, the primary focus of the investigator will be to minimize the number of vehicular stops on major facilities. A secondary objective will be to minimize the vehicular delay of access to and from side streets. This philosophy should also be maintained during traffic signal warrants analyses, capacity analyses, equipment evaluation (e.g., detector loops) and the development of intersection traffic control alternatives.

43.3.5.3 Interruption of Flow

The presence of traffic control at intersections along a highway is the single greatest factor influencing the progression of traffic flow in the highway corridor. Factors such as lane use, mid-block access and geometric features, to a lesser degree, also influence through-mobility. The level of flow interruption manifests itself in vehicular stops and vehicular delay and should be evaluated during the study. The primary method for measuring vehicular stop and delay in a highway corridor is by employing a travel time and delay analysis. The data collection methods and procedures for performing this analysis are documented in the ITE publications Manual of Transportation Engineering Studies and Traffic Engineering Handbook. The results of this analysis will help the investigator to assess:

1. the corridor's flow profile,
2. the total stopped-time delay experienced in the corridor, and
3. the corridor's average travel time and speed.

Upon completion of the travel time and delay analysis, locations in the corridor where the greatest interference exists can be identified, and potential improvements to mitigate deficiencies can be developed and evaluated.

43.3.6 Parking Analysis

During the study, it may be necessary to conduct a parking analysis. Parking analyses are typically conducted to:

1. assess the traffic conflicts caused by the type and location of parking and by the frequency of parking turnover;

2. determine the availability of on- and off-street parking;

3. evaluate the need to either increase or decrease parking capacity;

4. determine the orientation of on-street parking that is proper for the roadway's environment; and

5. assess whether or not on-street parking should be removed, maintained or, possibly, added in lieu of a vehicular, bicycle or pedestrian lane use.

The investigator should provide the safest and most efficient use of the roadway and consider the following factors when conducting the analysis:

1. location and nature of existing restrictions (e.g., no parking, no standing);
2. parking restrictions at intersections and crosswalks;
3. parking requirements for the disabled;
4. school bus stops and school crossings;
5. loading zones;
6. State statutes and local parking ordinances;
7. vehicular approach speeds;
8. existing and projected land use;

9. parking impacts on sight distance;
10. capacity of existing parking;
11. parking utilization;
12. crash history; and
13. parking turnover.

The following publications will provide the investigator with additional guidance when conducting parking studies and evaluating parking conditions:

1. Montana Code Annotated;
2. Parking Principles, HRB Special Report 125;
3. Manual of Transportation Engineering Studies, ITE;
4. Traffic Engineering Handbook, ITE; and
5. Chapter Thirty-one of the Traffic Engineering Manual.

43.3.7 Analysis of Pedestrian Crossing Activity

In Montana, there is an implied crosswalk on each approach to every intersection. Only those locations that experience pedestrians as a significant portion of intersection activity (e.g., central business district) and those that distinguish themselves with substantial pedestrian demand receive crosswalk signing and striping. The purpose of crosswalk signing and supplemental pavement markings is to warn motorists of an active pedestrian crossing. The purpose is not to attempt to create pedestrian channel and demand. This guidance also applies to mid-block pedestrian crossings. Additional purposes of pedestrian analyses are as follows:

1. to support a traffic signal justification;
2. to assess the need to adjust traffic signal timing;
3. to evaluate the need for a pedestrian refuge (e.g., median); and
4. to determine the need for grade separation.

The data collection methods and procedures for conducting pedestrian analyses are documented in the ITE publications Manual of Transportation Engineering Studies and Traffic Engineering Handbook. If the analysis involves a school crossing, see Chapter Forty-two of the Traffic Engineering Manual.

43.3.8 Street and Highway Lighting Analysis

The purpose of street and highway lighting is to increase the nighttime visibility of a roadway's geometric features and traffic activity (e.g., pedestrians, vehicles). The analysis should also address the nighttime conflict potential and assess the level of lighting required. For additional guidance on highway lighting, see Chapter Thirteen of the Traffic Engineering Manual.

43.3.9 Analysis of Highway Signing

During the study, it may be necessary for the investigator to evaluate the signing in the study area. The purpose of this analysis is to assess the signs' message pertinence and placement effectiveness. Highway signs are employed to either regulate, warn or guide the motorist. The investigator must gain an understanding of the intended message of the signing. Once the intended message is understood, the investigator should determine if the signing effectively conveys that message. This includes ensuring that the signing presents a clear and legible message in a conspicuous location. Also of importance is to ensure that the signing is located to provide the motorist with adequate advance notice of the message. As general guidance, highway signs should:

1. be capable of fulfilling an important need,
2. command attention,
3. convey a clear and simple meaning,
4. command the respect of road users,
5. be located to give adequate time for response, and
6. be sanctioned by law if they control or regulate traffic.

Signing analyses can range from a localized intersection evaluation to an analysis of continuity through a corridor. For additional guidance on signing, see Chapter Eighteen of the Traffic Engineering Manual.

43.4 FORMULATING CONCLUSIONS AND RECOMMENDATIONS

Upon completion of the study, the investigator will formulate conclusions from the results of the analyses conducted. The conclusions should adequately summarize and report the noteworthy findings of each of the study elements analyzed and their interrelationship. Each conclusion should follow a train of logic that will lead to and support the recommended corrective measures. The corrective measures developed to mitigate deficiencies in the study area should be feasible and relevant to the study's goal.

43.5 STUDY REPORT FORMAT

The study report should be organized in either a short or long report format. A short report will be prepared as a memorandum and is typically used for those studies that are straightforward and relatively easy to understand. Use the report format discussed in Section 2.1.1 as a guideline on how to present the results of the study in a short report format.

A long report will be prepared when a more comprehensive written presentation is necessary and will typically include the following components:

1. title page,
2. table of contents,
3. abstract,
4. introduction,
5. body of report,
6. conclusions, and
7. recommendations.

On a case-by-case basis, engineering judgment should be used in determining which report format is appropriate for the study. Under cover letter, a copy of the report will be sent to the requesting party and the appropriate Departmental personnel.