19 TRAFFIC ANALYSIS REPORTS

19.1 Purpose

Traffic analysis reports are a comprehensive explanation and accounting of the existing and future conditions or final recommendations and the decision-making processes for a project or plan. These reports can range from a technical memorandum describing conditions for a specific period or a single topic such as for micro-simulation calibration to a full traffic analysis narrative report on the entire analysis for a project. This chapter presents an overview of the basic elements that document the assumptions, methods, findings and recommendations of traffic analyses, report types, and reviewing analysis documentation of others. Topics covered include:

- Background
- Technical Memorandum
- Traffic Analysis Narrative Report
- Reviewing Analysis Documentation

19.2 Background

In many cases, the report text and associated diagrams are developed incrementally during the study process in the form of Technical Memorandums, and then circulated for review and discussion at key milestone points during the project review. Any revisions to the Technical Memorandums or new directions in the study analysis are carried forward and then compiled into a full Traffic Analysis Narrative Report (TANR) at the end stages of the study. The Final TANR serves as the legacy document for the study and must be comprehensive enough to explain and support the final recommendations and the decision-making process that led up to it.

19.2.1 Technical Writing Tips

Presentation of technical information in a clear, concise, and readily understandable way can be challenging in many regards. This section is not intended to fully answer those challenges, but to highlight several important tips that help to make a technical document achieve these goals. The document author is encouraged to avail themselves of training materials or mentors that could help them become proficient technical writers. A few basic tips to suggest in preparing any technical document include the following:

- **Target Audience**: The intended audience for the document will help to determine the appropriate level of assumed technical knowledge about the subject at hand, and their assumed understanding of the review, adoption, and implementation processes for a particular project. In general, most traffic reports will be developed for the review and implementation by staff within, or contracted by, ODOT. In general, these team members have minimal background in the technical traffic issues, but significant experience with the overall process

involved. To this end, the technical aspects and outcomes of the project need to be clearly explained with a minimum of technical detail necessary to support and explain the traffic analysis. This is very important because writing at the wrong level can generate unintended questions. More extensive technical calculations, findings, software input/output reports, and other reference materials should be attached to the document as appendices.

In most cases a document is normally circulated to the general public, the press, or other outside agency. In these cases, many of these more fundamental assumptions and process steps should be clearly detailed in the document. t Creating an executive summary written in simpler or plainer language that can also be a standalone document makes it easier to facilitate the public consumption of the information (e.g. used as a handout for a public open house). Presentations to project stakeholder groups are generally handled like any general public group, with the focus on overall process, criteria, outcomes, recommendations and next steps, with a bare minimum of technical content.

- **Tone and Style**: It is recommended that the document, regardless of purpose or scope, in all cases, remain objective, impartial, and impersonal so that the results and conclusions are untainted by any biases. It should be recognized that any internal ODOT document may be released for public review outside of the designated committee groups. This typically occurs by informal sharing in the interest of coordination or, more formally, through a public records request. All documents should be treated as if the general public and press will review them, even though many only circulate to the immediate committee members.

- **Readability and Document Structure**: The following sections of this chapter have suggestions about the narrative (i.e. "storytelling") general layout of the document, but these need to be tailored, as appropriate, to address individual study scopes and objectives. One of the keys for rapidly understanding materials is to divide the document into a logical, easy-to-follow flow of narrative text, summary tables and illustrations that are grouped according to key topics. In a TANR, for example, they would be grouped by chapter, or by sub-topic in a lengthier chapter. This basic structure provides a convenient framework for presenting and referencing a wide range of materials.

- **A Word About Acronyms**: A comprehensive list of acronyms used in transportation evaluations are assembled in the List of Abbreviations and Acronyms of this manual for reference purposes. Limit the number of acronyms, except for the most common ones that appear repeatedly throughout a particular document. The most common examples include: ODOT, v/c ratio, OHP and HDM. Excessive use of acronyms generally degrades the readability of the document, even when the reader understands their meaning. It is standard practice to introduce any acronym in the narrative when it is first used by defining it. In longer reports, it is also useful to attach a short list of all the acronyms used as a quick reference guide.

19.2.2 Diagrams and Illustrations (Figures)

Technical diagrams are a powerful resource for quickly explaining analysis assumptions, findings, and recommendations. One measure of a high-quality report allows readers to scan through the study tables and figures, and then be able to glean the general conclusions without reading any of the narrative text. For the purposes of traffic analysis reports, the technical diagrams include the following list of typical illustrations:

- Study area map
- Local street and highway system
- Traffic volumes on links or turning movements at intersections or junctions
- Intersection performance measures (e.g. v/c ratio)
- Segment performance measures (e.g. congestion heat map)
- Trip patterns or trip distribution routes
- Lane diagrams of existing or proposed intersection approaches
- Queuing diagrams
- Existing or proposed circulation routes within the study area
- Existing and proposed street or ramp centerline alignments
- Roadway cross-sections
- Alternative street improvement scenarios
- Land use and zoning maps

The best report graphics clearly label key reference streets, maintain a reasonable 10 to 12-point (minimum 8-point only if absolutely necessary) font size, and avoid trying to illustrate many layers of new information at one time. All diagrams need to have a legend clearly defining each symbol or line color/type used. A good rule-of-thumb is to limit the number of new layers to three or less for any diagram. Examples of different information layers are streets, peak hour volumes and functional street class. Complex diagrams can be developed in stages, explaining each new set of layers.

In general, street project alternatives are illustrated on separate diagrams. Depending on the overall layout of the project, a landscape orientation is generally better than portrait. Consider use of 11x17 paper format (i.e. foldout) to show larger areas or to show side by side groupings of alternatives instead of creating a larger number of smaller diagrams.

All documents need to be legible and usable in black and white. This can be an unavoidable issue with land use and zoning maps as these are typically created by outside parties and copied into a document. Unless many patterns are used, it is difficult to distinguish separate colors especially for individuals with differing levels of color-blindness.

For best results, it is recommended that diagrams be pasted into Microsoft Word documents via “Paste Special” and the “Enhanced Metafile” format. This will automatically allow for proper insertion without overwriting adjacent text, keeps diagrams intact (i.e. occasionally an issue with layered PowerPoint slides), and minimizes overall file size. Diagrams/figures created in PowerPoint ideally are grouped into a single

object before copying to avoid accidentally leaving parts behind or moving them out of position.

19.2.3 Tables

Tables offer a quick way to show and summarize analysis results and other repetitive common information across multiple periods or alternatives. Tables should deal with just a single subject to avoid excessive size and clarity issues. Typical table types include:

- Traffic count location, type, date/time, and duration
- Roadway inventory/characteristics
- Applicable operational state targets and local standards
- Intersection/segment operations (e.g. v/c's, LOS, delay, queues)
- Assumed project lists to be included in committed or financially constrained scenarios
- Historic crash analysis/characteristic/crash listing summaries
- Crash analysis results
- Multimodal analysis results
- Alternative comparison summaries

The preferred software to build tables in documents is MS Word as opposed to MS Excel, due to formatting issues, although MS Excel is acceptable for appendices especially with calculated values. Conditions exceeding a noted target/standard/threshold should be denoted with bolded white text on a black background. Column headers need to be understandable without excessive abbreviation, include units where appropriate, and be set off from the table body contents with shading.. Abbreviation definitions and meanings of cell shadings need to be footnoted at bottom of the table. Exhibit 19-1 shows a sample table showing the overall layout, header/cell shading, and footnotes.

Exhibit 19-1: Sample Table Layout

Segment	Side	From-To	LOS[1]
Main St	South	W Project Limit – Helman St	**E**
		Helman St – Oak St	C
		Oak St – E Main St	**E**
Siskiyou Blvd	South	E Main St – E Project Limit	C
	North	E Project Limit – E Main St	C
E Main St	South	E Main St –Third St	B
Main St	North	Third St – Oak St	**E**
		Oak St – Church St	C
		Church St – Helman St	**E**

[1]Black-shaded cells indicate that the multimodal LOS D analysis threshold has been exceeded.

Consider inserting landscape-oriented sections to show wider tables with more clarity instead of having too-narrow columns. Typically the maximum is six or seven columns on a portrait-oriented page. Table breaks across pages should be avoided, but ones that do, the headers need to be repeated on the next page. It is recommended that multi--page tables or a series of them are placed in an appendix to avoid creating disruptions for the reader.

19.3 Technical Memorandum

19.3.1 Purpose

A technical memorandum (TM) typically addresses one major stage of the project evaluation process, and presents the analysis, findings, and any potential next steps for that stage. Subsequent technical study stages build on the information presented in the previous memorandums, and allow for an incremental process to assess, refine, and build consensus on the preferred project. These technical memorandums are also described in Chapter 2 as part of the scoping considerations.

19.3.2 Products

The focus of a technical memorandum can vary widely, but, in general, they include the following technical materials, in a typical three-stage study development process. Smaller projects normally have a series of discrete memorandums while larger projects combine these memos into a TANR. Small projects (e.g. a single intersection) may have all the work combined into a single memorandum as multiple memos would likely be too much.

The overall study context/scope will determine how many memorandums will be necessary but as every project is unique with its own set of issues, the actual number of memorandums will differ. Certain memos can be combined, or an additional memorandum is needed to explain a certain issue or a new alternative option. Small projects could have the entire analysis documentation summarized in a single memorandum (almost a "mini" TANR). Regardless of how many memorandums there are, it is important to capture the noted elements below within each consistent with the overall project context and level-of-detail (e.g. a scoping-level intersection project will likely have less detail and reporting requirements than a multi-intersection congested project using micro-simulation). Any final draft technical memorandum that contains professional-level traffic analysis needs to be stamped by an Oregon-registered professional civil or traffic engineer.

TM#0 – Methodology & Assumptions: All ODOT traffic analyses must have a discussion on methodologies and assumptions used. Next to the scope of work, this is the most important documentation to have as it tells how the analysis work in the scope will be completed from what guidelines are to be used, to the data being collected, assumptions made, tools used, and reports produced. It is better practice to put more detail in this document rather than adding lots into the (contract) scope of work. This

document is critical for reviewers as it is supposed to give assurance to the reader that the work was done according to the agreed upon processes, avoids more questions later (i.e. are the existing seasonal factors correct or the proper tools used for the future volume projections, etc.), and generally shortens review times. Reviews can fall back to this document if the work does not follow it as the scope of work is normally not as detailed.

Normally, this a separate memorandum, but could be an appendix to another (e.g. existing conditions). Alternatively, if the analysis is relatively simple such as for high-level scoping, the discussion on overall methodology and assumptions can be a paragraph or two. This memorandum is based on the overall scope document and its task requirements (see Chapter 2) as it tells how the described tools and data are used to achieve the project outcomes.

This memorandum details out the methodologies and assumptions that are to be used in the existing conditions, the no-build future conditions, and the alternative for any volume development and analyses. Generally, the range of analysis methodologies and proposed tools from identifying count locations through simulation, including any safety and multimodal analyses needs to be included. Appendices can be included initially or added later in a revised memorandum to cover micro-simulation needs such as calibration data, methodologies, and results of calibration. This memorandum should be provided to and approved by ODOT Region Traffic (and the Transportation Planning Analysis Unit as necessary) before any analysis work is conducted. This helps to significantly reduce the amount of review by ODOT and potential re-work by the Contractor. Appendix 19A contains an annotated example methodology memorandum. This example does not necessarily include all methodologies that are applicable in each context.

TM #1 - Existing/No-Build System Analysis: This memo presents the key system inventory features and performance deficiencies (e.g. safety, geometrics, mobility, reliability, access spacing) that will shape development of study alternatives. This memorandum is important it establishes the foundation for the analysis of existing or no-build future conditions (e.g. operations, safety, accessibility). This allows direct comparisons of the benefits and impacts of an alternative to the current or future conditions. Otherwise, it is difficult to tell if an alternative is having the desired impact on noted existing or future issues.

Most analyses such as planning projects, grant applications, environmental/operational/safety analyses, or micro-simulation applications will require this documentation. Sometimes if a study effort is only for analysis of current conditions (e.g. operations) or is completely in the future (e.g. planning analysis using travel demand model scenarios) then there may be only documentation of existing or future conditions instead of typically both. An analysis without an existing and/or future comparison condition is incomplete and generally will not be able to answer all of the questions asked.

Depending on project type and size there may be more than one memorandum covering this stage. While not typical, the inventory gathering, and volume development could be

in separate memos. Larger, or more complex projects may have the existing conditions may be in a separate memorandum from the future no-build. Frequently, the methodology and assumptions are included as an appendix to this memorandum.

The memorandum typically includes statements on the project purpose and need, study area background, inventory data collected, and existing and future volume development. Discussed results generally include the historical and predictive (where applicable) crash analysis and any safety issues documented should be tied back to proven safety countermeasures (e.g. referencing the ARTS crash reduction factor/countermeasure listing) that can be identified to potentially improve safety performance. Other included discussion items are preliminary signal warrants, multimodal and reliability evaluations, access or spacing issues, noticeable operational issues, the intersection volume-to-capacity ratios, LOS, or other performance measures as appropriate, and the 95th percentile queues. Narrative text typically includes the positive or negative impacts to multimodal users, impacts to freight operations and truck routes, transit facilities, etc.

Comparisons should be made back to existing standards and thresholds (e.g. OHP interchange spacing standards, or HDM pedestrian crosswalk spacing) to identify all the applicable deficiencies (e.g. not just v/c and queues). These include operations, safety, multimodal, and geometric design. Many deficiencies will come from tool outputs, but many are field observed (e.g. vehicle consistently turning into the wrong lane because of too-short access spacing). A summary of the deficiencies by type for the existing conditions and future no-build conditions can also be included for easy reference.
The memorandum needs to include a set of appendices that support the results shown in the main body. These include:

- Volume development including seasonal and other adjustment factors, peak hour documentation, trip generation/distribution/assignment data, travel demand model assumptions/screenshots (Note that volume development spreadsheets typically do not fit well in a report format, so just a statement that this file is available upon request is sufficient). Raw counts are not normally included as the data is part of the volume development spreadsheet but can be if desired.
- Crash data – crash listings, HSM predictive calculations, SPIS lists, etc.
- Analysis output – Software tool output on lane configurations, intersection control, volumes, performance measures; preliminary signal warrant worksheets, multimodal analysis worksheets, performance measure calculations such as for intersection v/c, queuing, vehicle-miles traveled, etc.
- Micro-simulation or analysis tool calibration – advanced tools usually require some sort of calibration so reported conditions match the existing. This appendix is important as it gives documentation what was done to match to existing conditions and gives assurances to how the tool will properly reflect the future no-build and build conditions.

TM #2 - Preliminary Alternatives Screening: This memorandum presents the screening criteria, the initial roster of project alternatives and related options and the table-based scoring of how well the preliminary alternative or option matched up with the screening criteria. The alternatives and options shown in this memorandum need to

address the deficiencies shown in the existing/future no-build memorandums. Unless there are a lot of scenarios, alternatives, and/or options, many times this memorandum is optional. Generally, this memorandum is only necessary for medium to larger projects where there are several potential solutions identified or where multiple levels of analysis are needed to objectively consider all the context.

To help with screening of potential alternatives/scenarios the memorandum should also have a summary review of deficiencies, impacts, and project assumptions in earlier overarching planning documents such as Transportation System Plans (TSP) or Interchange Area Management Plans (IAMP). Many times the evaluation of plan projects is used as the basis for a higher-level screening for a greater-detailed analysis. These documents will have discussions on deficiencies (which are normally consistent with the subject plan if not corrected), impacts, and any project list assumptions.

Screening criteria are more general indicators of performance. There should be at least one level of screening criteria shown. However, depending on project size there may be multiple iterations each with their own set of screening criteria. For example, a fatal-flaw screening comparing against minimum acceptable standards followed by a goal/objective-based screening (e.g. environmental impact, impacts to the built environment).

Screening measures generally include key volume-to-capacity ratios or LOS's, model-based results (travel times, speeds, v/c ratios, or relative comparisons), predicted crash reductions, and high-level multimodal or reliability values. The reasons why alternatives/options were dropped, and any alternative naming and overall naming convention changes need to be recorded as this will be needed for the final narrative report and included in an appendix. Detailed screening criteria, scoring methodologies, and evaluation tables with related calculations are typically shown in tables in an appendix.

TM #3 - Future Alternatives Analysis: This memorandum presents the detailed evaluations of all scenarios, alternatives, or options that progressed through the screening process. This memorandum runs in parallel with the future no-build analysis and completes the analysis of future conditions. Any analysis that covers the future no-build either as part of TM#1 as noted above or in a separate memorandum will also need documented analysis of build alternative conditions. It is important to note that the future no-build is a viable alternative as sometimes it is the preferred solution. It also can include the impacts of new developments, financially constrained projects, or operational improvements (i.e. a new enhanced crossing, updated signal phasing, etc.) outside of the subject project that will occur beyond the existing condition timeline. The future alternative analysis compares build alternatives with each other and the future no-build.

Depending on review or outreach comments and related required changes, there could be an additional memorandum on refined, hybrid, or preferred alternatives. These alternatives have full performance assessments and any other related evaluations (preliminary environmental, compliance with standards, etc.) as defined in the study goals, objectives, and evaluation criteria. Additional volume development sections will

also likely be required as future build traffic volumes are usually different from the future no-build versions.

Narrative text should be included regarding the positive or negative impacts to safety for all users, on modes, impacts to freight operations and truck routes, transit facilities, etc. Specific impacts of the alternatives that need to be discussed include impacts of latent demand which can cause traffic re-distribution, peak spreading across time, or shifts across modes. . These can have substantial impact on the parallel road and multimodal networks for the better or worse. For alternatives that are on urban fringes or increase capacity or are in areas under economic stressors (e.g. cost of living) the memorandum should also discuss any potential impact of induced demand.

Detailed results typically include predicted crashes, multimodal analysis, preliminary signal warrants, turn lane criteria, volume-to-capacity ratio, LOS, predicted 95th percentile queues and required storage lengths, intersection/access/crosswalk spacing, and other operational performance measures (e.g., travel-time, average speed, reliability),

The memorandum needs to include a set of appendices that support the results shown in the main body. These include:

- Volume development for the alternatives, trip generation/distribution/assignment data, travel demand model assumptions/screenshots (Note that volume development spreadsheets typically do not fit well in a report format, so just a statement that this file is available upon request is sufficient).
- Crash data – HSM predictive calculations
- Analysis output – Software tool output on lane configurations, intersection control, volumes, performance measures; preliminary signal warrant worksheets, multimodal analysis worksheets, performance measure calculations such as for intersection v/c, queuing, vehicle-miles traveled, etc.
- Alternatives considered but dismissed – Documentation of alternatives/scenarios/options considered but screened or dropped out. At a minimum this needs to be a short description and reason for dropping. Figures are optional but very helpful to include.

19.3.3 Distribution

The technical memorandums should be distributed to the project team or at least to the project leader/manager/planner for review and comment. Sometimes a smaller internal working group will review these memorandums first for preliminary comments before distribution to other ODOT units and project stakeholders. Depending on the study context, others should be included in the distribution (e.g. ODOT region traffic manager/engineer, modeling staff, lead workers/manager, etc.).

19.4 Traffic Analysis Narrative Report

19.4.1 Purpose

Most of the traffic analysis will be completed by the point that the Draft Traffic Analysis Narrative Report (TANR) is developed. The purpose of this report is to present the final solution(s) selected from the study alternatives. This includes other documentation created as described in other portions of this manual (e.g. microsimulation calibration memorandum) as part of the full product.

19.4.2 Product

The Draft Traffic Analysis Narrative Report (TANR) presents the full study process and outcomes incorporating the interim Technical Memorandums, feedback from team committees, public involvement comments, any new information, recent decisions, or any scenarios/alternatives/options not captured in earlier memorandums. The major step to be completed with the TANR is to provide conclusions on the function of alternatives from a traffic analysis standpoint.

These can vary in length as it is really a function of geographic scope, the type of analyses included, the level(s) of detail considered, and the total number of scenarios, alternatives, or options that were analyzed in full detail. If the context and detail level of the project leads toward not requiring or needing a single summary report at the end, then consider doing a series of technical memorandums as described in Section 19.3. Larger, more complex, or longer duration efforts will likely result in substantial content to summarize which is best done in a single document. A TANR only has a few optional sections, so most of the following detail will be needed to be considered complete.

Projects that result in environmental documents (e.g. EA or EIS) require a final technical report for transportation which the TANR will cover the need. Refinement studies (especially any with planning-environmental linkages) should use a TANR to summarize the project as these typically have multiple levels of alternative analysis detail (e.g. high-level scenarios in a travel demand model, preliminary alternative screening using sketch - level tools, and followed by full operational analysis).

Ideally, the TANR is developed from merging previous technical memorandums to save on effort and time. The TANR shall be descriptive with necessary explanations of why certain conditions or results exist or why they do not (e.g. traffic diversion from latent demand). This is more than a simple reporting of performance measures as the analyst needs to tell the “story” (i.e., the narrative) of what the conditions are now, projected to be in the future, and the outcomes of the future alternatives that address the earlier identified needs. The selection process for a preferred alternative overall uses the analytical evaluation outcomes, relative scoring evaluations to reduce the total alternatives to a single, a few at most, or a creation of a hybrid alternative that combines several alternatives that best meet the study objectives. The narrative discussion needs to be seamless through the alternative development process, so that the reader knows why

each alternative was created, why it remains, or why it was dropped. This is necessarily a collaborative process with established team members, stakeholders, local jurisdictions, and affected ODOT technical units.

The report itself is generally developed consistent with the following standard outline below. Project context, detail and scope will determine the degree that each item is needed. Larger, more complex projects will generally need more detail.

Sample Outline

- **Cover Sheet**
  - Agency/Company Title, Division, Unit, City, State (in header, footer or along bound edge)
  - "Project Title Traffic Analysis Narrative Report" (to clarify that this is just the traffic analysis)
  - City (if applicable) and County
  - Highway Name, Number and Route Number
  - Milepoint Range
  - Month and Year report published
- **Title Page**
  - "Project Title Traffic Analysis Narrative Report" (to clarify that this is just the traffic analysis)
  - Highway Name, Number and Route Number
  - Milepoint Range
  - Full Mailing Address
  - Prepared by and reviewed by (including stamp by preparing PE or reviewing PE if preparer is not registered; requires signature of non-registered preparer)
- **Table of Contents, List of Figures, List of Tables, List of Appendices**
- **Executive Summary**: Summary of report including purpose, need, background, scope of alternatives, high-level summary of results, alternative screening/evaluation, and re-statement of conclusions. These range from a couple to a half-dozen pages depending on the number of alternatives. Study area and alternative figures can also be included to increase understanding. The takeaways for the reader should be the same as if they had read the entire report. For complex efforts, writing the executive summary in a way that it can be standalone may help in the digestion of the material especially for non-technical audiences.
- **Background Information**: Contains an overview of the study area including vicinity and study area maps, affected facilities and jurisdictions, a table of operational targets and standards for the applicable jurisdictions, past project or planning decisions that generally influence outcomes, a general problem statement, and objectives for the study.
- **Existing Conditions**: Contains discussion of inventory and analysis of base year facility and operating conditions. This includes five-year historical crash summaries, any applicable Highway Safety Manual-based Part B screening and predictive (i.e. expected crashes) Part C crash analyses, volume development, facility-level roadway and multimodal results, and comparison with applicable targets, standards, and thresholds. Normally, discussion includes any constraints

or impacts to freight routes, multimodal facilities, and potential of traffic diversion. Tables of analysis results and/or figures are necessary to summarize information and provide understanding. An optional list of existing deficiencies is a good way of summarizing issues across multiple subjects.

- **Future Year Forecasts and Needs (No-Build)**: Discussion of future year volume development including summary of travel demand model scenarios, horizon (design) year traffic forecasts, HSM predictive crash analysis, and performance assessment on the existing street system with no project improvements across all applicable modes. Discussion typically includes any constraints or impacts to freight routes, multimodal facilities, potential of traffic diversion, and latent and induced demand (see Section 6.12.2). Tables of analysis results and/or figures are necessary to summarize information and provide understanding. An optional list of future deficiencies is a good way of summarizing issues across multiple subjects to help ensure that these are addressed by the build alternatives. Previously agreed upon network assumptions need to be documented here which includes committed (i.e. funded for construction STIP & CIP projects), planned but financially constrained projects in a TSP or RTP, and private development land use projects. See Chapter 9 for more details.
- **Preliminary Alternatives Screening**: Optional, as it depends on if there were enough scenarios or preliminary alternatives to require screening. Includes screening/evaluation criteria and process, concept alternative descriptions to address outstanding needs, and preliminary screening of alternatives along with reasons for dropping alternatives from further evaluation (see Chapter 10). The evaluation matrix and related details should be placed in an appendix.

- **Alternative (Build) Results**: Discussion of performance results for each analyzed alternative for the build (i.e. year of opening), interim (if applicable) and design years for the same comparisons across targets, standards, and thresholds for all applicable modes as done for the existing and future no-build conditions. Crash analysis also includes specifics on potential countermeasures to address safety issue locations in the existing and future no-build conditions. Typically, discussion includes constraints or impacts to freight routes, multimodal facilities, potential of traffic diversion, and latent and induced demand. Tables of analysis results and/or figures are necessary to summarize information and provide understanding.
- **Alternative Summary**: The alternatives are compared against each other, including a summary table, according to appropriate performance measures. There should be no new material introduced in this section as it is intended to summarize the build results. The future no-build alternative is normally also included for comparison as this also is a viable alternative (i.e. to do nothing). The summary table represents each performance measure (or family of measures) at a higher level. For example use, “Number of intersections exceeding targets” instead of showing individual v/c’s. Exhibit 19-2 shows an example summary table.

Exhibit 19-2: Example Alternative Summary Table

Measure	No-build	Alt 1	Alt 2	Alt 3
Number of intersections over capacity	3	3	3	2
Number of intersections over LOS D	9	7	5	6
Total Main St SB approach delay (s)	69	73	68	114
Number of queue blocked intersections	9	7	8	8
Average percentage of segments at BLTS 1 or 2	87	95	95	98
Average percentage of segments at PLTS 1 or 2	58	67	67	67
Average of unsignalized Main St crosswalk delay (s) for options	696	240	60	157

- **Conclusions**: The analyst needs to be careful to make conclusions based on the traffic analysis results, rather than recommendations on a preferred alternative, as the best alternative from a pure traffic standpoint is unlikely to be the best overall given complete context and considerations (e.g. impacted environment, pedestrian safety). The conclusions are essentially a summary of the main points coming out of the Alternative Summary section. These should also be re-stated as part of the Executive Summary.
- **Further/Future Areas of Study/Next Steps**: Optional; formatted in a bullet list or short paragraphs
- **Appendices**

Appendices normally include the following subjects with the items listed for each below. Depending on the project scope and size, some of these are normally combined or split apart for easier reference.

  - Crash History: Detailed historic yearly crash summary listing for each roadway in study area, HSM Part B screening-level, and HSM Part C predictive crash analysis. Background on selected countermeasures (e.g. ARTS Crash Reduction Factor information, CMF Clearinghouse details) can also be included.
  - Inventory: Spreadsheet-type data listings of roadway, bicycle, and pedestrian facilities for segments and intersection locations commensurate with level of detail required by methodology and tools used.
  - Record of Calibration (required if micro-simulation was performed or calibratable tools like SIDRA were used): The calibration record will vary in detail level and length by project and specific tools used, but the record needs to address the following items:

        - List of key calibration locations
        - Calibration data gathered for the key locations
        - Measures of effectiveness (MOE) needed to meet calibration thresholds
        - A table or list citing all changes that were made to the inputs or model modules to achieve calibration, beyond the standard changes that occur after collecting field inventory (see Section 3.3). This list or table should include:
            - the issue that was occurring before the change was made,
            - the goal of the change, and
            - how the change improved the calibration.
        - For each Measure of Effectiveness (MOE) of the calibration, include a table that shows the before and after results for each MOE. Before results have all standard inputs, but no changes beyond the standard adjustments. After results have all changes to achieve calibration were included in the model.
        - The record needs to indicate that the key calibration locations met the calibration standards.
    - Volume Development: Count locations/type/duration/dates, text explanation (along with figures/tables as needed) of base and future volume development across all applicable modes including any seasonal/historical adjustments, trip generation/distributions, trip patterns via select-zones/links, model scenario descriptions, and model post-processing including any significant manual assignment adjustments. A list of network assumptions including committed and financially constrained projects needs to be included along with any related land use and zoning maps. Appendix header page should include a note that volume development spreadsheets are available upon request since most of these are not print or online document friendly.
    - Existing Year Volumes: Peak hour(s) volume and lane configuration diagrams and daily roadway segment volume diagrams for the existing (base) year. If available, also include bicycle and pedestrian facility segment and intersection volumes.
    - Existing Year Analysis Inputs & Outputs: Analysis software inputs and formatted output reports (e.g. v/c, LOS, queuing, multimodal, reliability). A spreadsheet of critical intersection v/c ratio calculations including phase timing and critical pair identification should be included for any signalized intersections.
    - Future No-Build Volumes: Peak hour(s) volume and lane configuration diagrams and daily roadway segment volume diagrams for the future no-build years. This can include the year of opening/build year, interim years (i.e. 10 years beyond the build year) and the future horizon/design year (i.e. 20 years beyond the build year). If available, also include bicycle and pedestrian facility segment and intersection future volumes.
    - Future No-build Analysis Inputs & Outputs: Analysis software inputs and formatted output reports (e.g. v/c, LOS, queuing, multimodal, reliability).

A spreadsheet of critical intersection v/c ratio calculations including phase timing and critical pair identification should be included for any signalized intersections.

- Alternatives Considered but Dismissed: Short description of each dismissed alternative including why it was dropped listed in chronological order along with any optional figures for further-developed alternatives. This appendix is important as it has been generally found over time that alternative disposition is not well documented as it is a source of project questions especially when an "old" idea is re-introduced such as in a public meeting or comment letter.
- Alternative (Build) Volumes: Peak hour(s) volume and lane configuration and daily roadway segment volume diagrams for each alternative. Each build, interim (if applicable) and horizon/design year for each alternative can be a separate appendix or logically combined depending on the project. If available, also include bicycle and pedestrian facility segment and intersection future volumes.
- Alternative Analysis Inputs & Outputs: Analysis software inputs and formatted output reports (e.g. v/c, LOS, queuing, multimodal, reliability). A spreadsheet of critical intersection v/c ratio calculations including phase timing and critical pair identification should be included for any signalized intersections. This is a critical inclusion for any reviewers.
- Analysis Methodologies: Final methodology memorandum in entirety (i.e. including any appendices). Also, include any analysis methodology that was created or updated later after the memo (e.g. documentation of a screening-level or a reliability analysis added in later).
- Environmental Traffic Data (required if noise, air quality or greenhouse gas (GHG) modeling was performed): For No-Build and Build alternatives, including link diagrams and tabular traffic data for noise, air quality as required, and GHG for applicable years and roadway segments.

In addition, electronic-only documents should be assembled and packaged (i.e. in a zip file) to be provided to reviewers. These include:

- Volume development (with or without model post-processing) spreadsheet workbooks
- Deterministic (i.e. HCM-based) analysis software files
- Critical intersection v/c spreadsheets
- Final micro-simulation/animation runs
- Other documentation that did not translate well in the report format

The narrative report appendices, and other related materials (e.g. volume development spreadsheets, micro-simulation files) may also be copied to a USB flash drive or other storage device/location for a backup copy. Flash drives and other physical storage media should be retained in the physical project file. A shortcut (or a direct location link) should be documented for any online backup/archive storage locations.

A draft of the narrative needs to be sent, as a minimum, to the project leader/lead planner

and the corresponding region traffic engineer and/or manager in the Region Traffic office. Depending on the context (more are needed for a NEPA project versus a planning project) other groups are the Traffic-Roadway Section, Environmental Section, active transportation and mobility liaisons, roadway design lead, corresponding consulting staff, local jurisdiction engineering staff, and any others who might be affected, for review and comment. Allow 3-4 weeks for a thorough technical review of the narrative, appendices and related on-line only materials. Generally, this review is completed within two weeks for smaller projects.

Consider attaching a blank comment log to capture substantial comments and later responses. The traditional track change and comment form can be used for smaller projects or as a second round of editorial review for larger ones. About two weeks need to be allowed for responding to comments.

19.4.3 Distribution

Upon incorporation of comments received on the draft, any draft watermarks, “Draft” language on the header/title/headers/footers is removed and the TANR is signed and stamped on the title sheet by the responsible professional engineer.. The document and the appendices bundle (i.e. save as a group) needs to be saved as separate pdf files for distribution to prevent accidental changes and corruption. The pdf version should be sent to the project leader/planner, the consultant project leader, and main project contacts in the appropriate Region Traffic office, other ODOT sections, and local jurisdictions.

19.4.4 Document Close-out

After distribution of the TANR, and while the project analysis work is still fresh, this is a good time to do a documentation clean-up in any paper or electronic files. This is important as while the TANR (or final technical memorandum for a smaller project) represents conclusion of the analysis work, it also represents the start of the next phase such as environmental documents or design. Also, while things make sense “today”, but after months or years have gone by, direct recollections fade.

During this future work it is common that questions will be asked on the preferred alternative, or clarifications on analysis assumptions (e.g. TSP financially constrained project inclusions or did the future volumes include the impact of latent and induced demand) or whether this past work is still valid in cases of a future phase or activation of a “shelf” project. These might show up in correspondence, project meetings, environmental document comments or even in public hearings that will require figuring out what was done. In some cases this will involve new analysis or corrections/modifications that will require additional documentation through a new technical memorandum(s), or an updated TANR. Anything that can be done today to improve understanding and save time in the future by the analyst, or their successors is important.

Old or obsolete TANR or technical memo drafts should be deleted to clean up project files and to avoid confusion in the future, so it is clear what was used to develop the existing, future, and alternative conditions and results. The existing conditions, future no-build conditions, and each alternative need to be in separate folders if they are not already. Final analysis files should be in their own separate folders and noted with "_FINAL." Date stamps in folder and file names are also helpful. Readme text files should be added for any future reference to folder contents (although the best time to create these as the work proceeds) or to back up assumptions or decisions made in specific files. Spreadsheets can have cell notes added to clarify sources or calculations.

19.5 Reviewing Analysis Documentation

Often an analyst will be required to review work conducted by others, whether it was performed within the Department by a peer or by a consultant. All traffic analysis work (either done internally by ODOT staff or by a consultant) must be reviewed by an Oregon-registered civil or traffic engineer. At a minimum, this is a peer review if both the analyst and reviewer are Oregon-registered civil or traffic engineers. The reviewer should be the analyst's lead worker/supervisor as they should be involved in the flow of the work. If the analyst is not registered, then the reviewer must be the lead worker/supervisor who is registered as they must be familiar with the work as the professional responsibility falls under them. Work performed by a non-registered consultant analyst must be reviewed by their registered lead worker/supervisor prior to submission to ODOT for review.

The review parameters such as who the reviewers are, what is going to be reviewed, and what level of detail the review will be documented at should be done before the review starts. Ideally, two weeks is the desired review turnaround time to allow for other workloads, time off/emergencies, etc. especially when full reports and memorandums including appendices and electronic files are to be reviewed. Normally, more time is needed to review a TANR and appendices as noted in the previous section.

The following section provides general guidance for reviewing traffic analysis that is applied to any type of analysis project. Specific guidance for the review of Traffic Impact Analyses/Statements (TIA/TIS) is found in ODOT's Development Review Guidelines.

19.5.1 Purpose of the Review

The reviewer should generally know what the purpose/scope of the review is as this establishes what the review needs to cover. Some considerations include:

- Audience – is this only for internal technical staff or is this to be included as part of a public document (i.e. guidelines) or public-facing document for a web page or handout?
- Completeness – is this a rough draft to start a process or a discussion or is this to report analysis, discussions, or decisions?
- Full Documentation – are there short-cuts taken like referring to other past memos/reports/projects? Note that report readers might not have access to the

other reports. Reports ideally are stand alone, so past memos need to be provided separately or as appendices. For example, just stating that "US 101 in the project has an OHP mobility standard v/c ratio of 0.85 in Tillamook", leaves out the missing classification information which includes items like what is the highway classification, expressway, freight route, or Special Transportation Area designations, etc.

- Accuracy - need to verify things like OHP/HDM targets and standards (including any alternative targets and performance measures), speeds, lane configurations and traffic control
- Consistency - thinking "outside the box" may be good in some cases, but it should not carry through freely to documentation as readers are looking for specific types of information and having to sort through pages of data can be difficult.

19.5.2 Organization and General Format

The report should be set up for the specific (target) audience, using words and sentences (word size and sentence length) appropriately with acronyms defined and used minimally. Most readers need some sort of organization, so thoughts are grouped linearly (i.e. time, location, or process) or grouped by topic (i.e. safety, configuration/geometrics, policies/standards, procedures, and findings/conclusions).

The report needs to have good readability. Color does not always copy well as graphics usually just turn into multiple impossible to differentiate shades of gray. Generally, use patterns in graphics to distinguish different features as much as possible. Typeface size for general text needs be at least a 12 point (or larger) and limited to standard fonts with few "extras" (i.e. Times New Roman, Georgia, Arial, Verdana). Footnotes in text, tables or figures need not to be any smaller than 10 point. Remember that clarity dissolves with copying and not all programs use all fonts. All pages are numbered as review comments typically are tied back to a reference page/paragraph/line. Line numbers are optional and are more common for larger reports or for significant efforts.

White space throughout the document should be evident instead of continuous lines of text. Paragraphs after paragraphs of text lead to low readability. Tables are better but tend to be complex especially if multiple variables are involved. Tables make data easy to read by making comparisons. Failing/exceeding threshold values should be pointed out with emphasis (i.e. bolded, shaded, etc.). Large tables that continue across multiple pages or are larger format (i.e. 11x17 landscape orientation) are best placed in separate appendices to avoid disruption to the reader.

Drawings and figures are better than long-winded description paragraphs, but some text is still needed to point out or explain to the reader the important features, issues, key locations, etc. Numbers are typically noted and balanced appropriately (e.g. future volumes rounded and not to the exact amount; or not losing traffic between ramps on a freeway). Information needs to be limited to about three layers on a single diagram (e.g. street names, classification, and volumes).

19.5.3 Checking Information

A reviewer does not have to check every fact and figure but normally covers major sections and areas that affect the results of the work. Some of these areas are:

Study Area

When reviewing analysis conducted by others, knowledge of the study area is typically beneficial. The reviewer should first examine all study area mapping and use available aerial/street-level images available. If practical and if the effort is large or important enough a physical visit can be performed.

Roadway Classification and Jurisdiction

This establishes what type of road it is and who controls it. This will determine what overall performance measure to use (state or local) and the specific value. This also includes special designations such as for level of importance, freight routes, expressways, and Special Transportation Areas which also affect the performance measure values.

Analysis Methods and Processes Expectations

The document should state its purpose and need as that establishes the level of detail needed in the analysis, the answers that are needed and what the expected results are. Review the methodology memorandum to make sure that the assumptions, parameters, and tools to be used in the existing conditions, future conditions and the alternatives is appropriate for the level of detail of the work and consistent with the overall scope of work.

If the work follows the memorandum and any corresponding scope of work (See Chapter 2), then the rest of the review is streamlined for both sides. Any disagreements need to be taken care of before analysis work is started to minimize rework and issues later. Keep in mind assumptions made by the analyst performing the work normally have a significant effect on the analysis results, even if specific analysis procedures are followed correctly.

Each of the major analysis areas to be covered in the project as noted in the scope also need to be included in the methodology memorandum (e.g. travel demand modeling, safety analysis, multimodal analysis, reliability, microsimulation). For example, if the project is within an area represented by a travel demand model such as in a MPO area, then the model must be used to develop future volumes and alternatives. The specifics relating to model name, version, years, scenario assumptions should be stated in the methodology memorandum or at least in the volume development section or appendix of the future no-build and build alternative memorandums.

Safety analyses (see Chapter 4) should have some sort of historical analysis of trends and summaries. If there are more than a half-dozen intersections, then some sort of screening

methodology using crash rates, or applicable HSM Part B methodologies is generally expected. The number of locations needing predictive HSM part C analysis performed and crash mitigations ideally are minimized. Any countermeasures used need to come from the CMF Clearing house (with three stars or better, similar volumes) or the ODOT ARTS CRF hot-spot and systemic crash listings.

Multimodal analyses (see Chapter 14) need to be at the appropriate level for the project type. At a minimum this will be qualitative multimodal assessments (QMA) or a level of traffic stress (LTS) analysis for most planning projects. Detailed refinement planning and projects are ideally using multi-modal level of service methodologies. Any modifications such as additions or subtractions from index-level methods should be documented (e.g. adding grades to LTS). Subjective methods like QMA need documentation on what is good-fair-poor for each factor used.

Certain analysis tools (e.g. SIDRA) and microsimulation tools (e.g. SimTraffic/Vissim) require calibration for existing conditions to ensure that reported results are correct. See Appendix 12/13A and Chapter 15. Calibration data, key locations, thresholds, modifications done, and result comparison with thresholds need to be provided in a methodology memo, specific memo, report section or appendix. Reviews should not be deemed complete until this is available and reviewed.

Other specific analysis methodologies need to have assumption sources documented (e.g. free-flow speed basis, congestion thresholds for reliability, use of private "big data/information" sources, checking for latent & induced demand effects). Electronic-only files such as volume development spreadsheets, Synchro/Vistro/SIDRA/HCS scenario files should be provided initially as attachments.

Data

With any type of technical analysis, the proper collection and processing of data is critical to obtaining accurate results. Before reviewing the analysis itself, verify the data used is appropriate for the analysis conducted. Consider things such when was the data collected, type of data used, and whether any processing of data (e.g., volume balancing) was conducted correctly. Does the inventory data collected adequately support the desired tools (e.g. AADTs for HSM analyses, sidewalk width for pedestrian analyses, private information origin-destination data for weaving sections)?

Appropriate Factors

This means checking that the count data was correctly obtained and correctly seasonally adjusted to the 30th highest hour (or another applicable alternative standard) and future year. Are seasonal adjustments less than 30%? Are all the counts adjusted to a common base year? Are other analysis parameters correct such as the peak hour factor, heavy vehicle factors, and saturation flow rates? Is the appropriate future methodology followed (e.g. historic, cumulative or travel demand model)? See Chapters 5 and 6 for more information.

Spot Checks

Typically, the reviewer performs a few quick checks by pulling the cited data and verifying correctness. With the given data, can the reviewer reproduce the seasonal and growth adjustments? Or can they follow the methodology used in a volume development or future post-processing spreadsheet? Do the volumes balance between intersections where there are no driveways or uncounted locations (e.g. between interchange ramp terminals)? If there is an extended distance between study intersections, is the volume increase/decrease consistent with the land uses?

The calculations performed in the analysis should be checked for computational errors, and procedures used should be appropriate for the given situation and in compliance with accepted ODOT practices. Knowledge of the study area, prevailing traffic conditions and accepted ODOT analysis procedures will aid the reviewer in determining which assumptions are appropriate, and which are not.

Correct Processes

Make sure that what is reported was analyzed with the correct program or tool. Listed below are generally the expected tool or program for each analysis type. Note that alternative tools and processes are allowed that are not listed below, but there must be documentation in a reviewed and approved (Region Traffic and/or TPAU as appropriate) methodology memorandum or other correspondence that explains the reasons for using the alternative tool/process. The methodologies that use the tools and processes below in the analysis should be consistent with the final d scope of work, workplan, or methodology memorandum.

- Existing volume development seasonal adjustments – ATR On-site, Characteristic Table or Seasonal Trend Table (see Chapter 3) documented in a spreadsheet
- Axle factoring for roadway tube non-classification counts – OTMS (see Chapter 3)
- Future volume development –
    - Historic, cumulative, travel demand model (see Chapter 6, 8, and 17), or Statewide Integrated Model (see Chapter 7). Note that for MPO areas, use of the regional travel demand model is required. Where small urban travel demand models exist, they should be used (see Travel Demand Model Map). For all methods, there should be spreadsheet workbook available illustrating the calculation steps with proper headers and callout/cell notes as needed.
    - Alternative mobility standards (see Chapter 9) – Documented in a volume development spreadsheet showing steps
    - Peak hour spreading (see Chapter 8) – Region 1 Hours of Congestion tool, spreadsheet documentation
    - Latent & induced demand (see Section 6.12.2) – Documented with travel demand model/SWIM plots/output as required by study area geography

- Safety analysis (see Chapter 4):
    - Historical – ODOT crash reports/summaries/rate tables with documented work in a spreadsheet workbook
    - HSM Part B screening – ODOT calculator spreadsheet tools for Critical Crash Rate and Excess Prohibition of Specific Crash Types or equivalents
    - HSM Part C predictive analysis – ODOT HSM spreadsheets, ODOT ARTS CRF list and/or CMF Clearinghouse, ISATE freeway/interchange tool, or commercial equivalent
    - Geometric design screening – Spreadsheet documentation of functional area, sight distance, access spacing, and conflict points
- Intersection analysis (see Chapters 10, 12 & 13) – Synchro, Vistro, HCS, or SIDRA. Signalized intersections need to have a supporting spreadsheet workbook for v/c calculations for all programs except Vistro.
- Future signalization (see Chapter 12) - ODOT Preliminary Signal Warrant form or equivalent of MUTCD Warrant 1
- Roundabouts (see Chapter 12) – Spreadsheet tools, HCS, Vistro, or SIDRA (preferred)
- Queuing (non-congested conditions; see Chapter 12 & 13) – ODOT unsignalized queuing equations, Synchro, Vistro, HCS, or SIDRA
- Queuing (congested conditions; see Chapter 15 & Appendix 12/13A) – SIDRA, SimTraffic, or Vissim with calibration documentation
- Rural mainline turn lanes (see Chapter 12) – Documented ODOT turn lane criteria
- Segment/facility analysis (see Chapters 10 & 11) – HCS, ODOT two-lane highway follower-density method, or related spreadsheet tools
- Reliability analysis (see Chapter 11) – HCS, FREEVAL, RITIS (existing only), HERS (future only)
- Multimodal analysis (see Chapter 14) – Qualitative MMLOS, Bike/Pedestrian LTS, Simplified/streamlined MMLOS spreadsheet tools, NCHRP 562 screening tool or equivalents
- Environmental traffic data (see Chapter 16) – Applicable spreadsheet workbooks for noise, air quality, and GHG traffic data as appropriate

Correct Targets/Standards

Once the adequacy of the analysis has been verified, compare the results to ODOT's and any local jurisdiction's adopted performance measures (see Chapter 9) including any alternative targets/standards/measures. If alternative targets/standards or performance measures are proposed, check to see if the analysis steps establishing the target/standard (see Sections 9.2.3 and 9.2.4) are documented. Check any proposed mitigation against ODOT's (or local jurisdiction as appropriate) design standards. Often the review process will require coordination with other units within ODOT or other governmental bodies that have specific expertise in, or authority over, certain elements of the design or approval of the mitigation proposed.

Reasonableness

In addition to technical accuracy, the results of the analysis should be evaluated using a "reasonableness" test. The reviewer should compare the subject data, such as the traffic volume counts, lane configurations and traffic controls, and determine whether the conclusions and recommendations of the study are reasonable. This can be done by checking the operational results (e.g. queuing impacts, corridor travel times, average speeds, lane utilization, and lane changing/merging/diverging/weaving behaviors). For example, if the results are showing congested conditions or volumes are shown to be high at a particular location, it would be expected to see substantial spatial queuing and slower speeds. This type of test often helps pinpoint sources of error in analysis and might reveal questions likely to arise when the project is presented to the public. It does help if the reviewer is familiar with the study area in question or can ask others who are especially about any operational issues that occur (e.g. poor lane utilization for a dual left turn caused by an immediate downstream right turn).

Addressing Errors

When sources of error are detected in the analysis, the reviewer typically notes not only just the error itself, but acknowledge the significance of the error to the results of the analysis. There will be times when correcting the error requires a substantial amount of work, but the results of the corrected analysis would not be significantly different, and the recommendations of the study would remain unchanged. If the documentation of the process is important to avoid questioning/legal challenges in the future, then it is generally best to fix the error. Noting the significance of the error ahead of time will enable ODOT to determine whether correction is necessary or cost-effective.

19.5.4 Documentation

- Typically, report documentation includes the following: Study area map
- Methods and assumptions (ideally in a separate section/memo in an appendix)
- Applicable polices, standards, background conditions
- Local street and highway system including (freight routes, pedestrian, bicycle, and transit modes)
- Data and inventory summary as well as source(s) of the information
- Traffic volumes (segments and/or intersections)
- Volume development – raw counts, system peak hour, adjustment factors, unbalanced volumes, base year, build (opening) year, future years, model versions/scenarios used, evidence of consideration and or analysis for induced and latent demand
- Trip patterns/distributions
- Lane configurations
- Land use and zoning maps
- Circulation routes
- Existing or proposed scenarios/concepts
- Existing or proposed alignments/alternatives
- Existing & future no-build and build alternative analysis
- Summaries as appropriate, including any evaluation criteria, screening matrices, cost estimates, benefit-cost studies
- Conclusions
- Technical data included in appendices with electronic files available upon request

Missing sections or other errors/issues found are normally addressed in a comment log or memorandum or email, so the reviewer's comments can be documented as well. Pages, sections/tables/figures/exhibits, and/or line numbers need to be identified for easy reference. Many times the team/project or planning lead will be consolidating comments from several reviews and reconciling any conflicts between reviewers.

Appendix 19A – Sample Methodology Memorandum