Chapter 10

SPECIAL DESIGN ELEMENTS
10.1 AERONAUTICS

10.1.1 GENERAL

Transportation modes often link to each other enabling goods and services to be transferred from one mode to another. The influence areas of the individual modes often overlap each other. Airports that are near a project must be reviewed for impacts to the project and the airport.

10.1.2 DESIGN ELEMENTS

Projects within the vicinity of an airport must be carefully examined to determine any potential conflict between the two transportation modes. Airport master plans should be reviewed to determine potential impacts to projects. Federal Aviation Regulations - Part 77, “Objects Affecting Navigable Airspace,” and Oregon Administrative Rules, Chapter 738, Division 70, are the documents to be complied with involving airport clearance study projects involving structures and other potential obstructions to air navigation. The Regional Technical Centers are responsible for completing airport clearance studies when required.

Projects that are near airports should be reviewed for obstructions or elements that may impact the air space. Roadway elements such as bridges, signals, illumination poles, or equipment that is used on these types of roadway projects may have an impact on air space. Even a proposed roadway with only the height of the vehicles as the only vertical impact may penetrate the imaginary flight surfaces. Location of drainage ditches and retention ponds can have an impact on airports by potentially attracting waterfowl to the area. The type of and pattern of illumination located near an airport should be reviewed for lighting conflict between the project and the airport. Glare shields may be needed to prevent signal light glare to the pilot.

Roadway projects in the vicinity of airports need to accommodate the type of cargo and goods that travel through airports. Turning radii, travel lanes, or additional dedicated turn lanes need to be considered in the accommodation of vehicles moving such cargo and goods. Appropriate signing for airports must be addressed in project design. Projects that add lanes should consider adding the lane away from the airport for clearance purposes. Potential for rail, light rail, bicycle and pedestrian, and transit needs should be examined for projects near airports, providing the necessary links between the different transportation modes. The existing Transportation System Plans should be reviewed to determine any related airport transportation needs.
10.1.3 CONTACTS

The Oregon Department of Aviation should be contacted for assistance when any proposed project is within 20,000 feet horizontally of an airport; to assist in determining compliance needs with federal regulations; and to ensure proper coordination between the two divisions.
10.2 BRIDGE

10.2.1 GENERAL

It is important to contact the region bridge unit when a project involves some type of structural element, whether it is a retaining wall, culvert, bridge, cantilever sign support, etc. The designer should stay in contact with the bridge designer as a project develops to ensure that the roadway and bridge elements of a project fit together.

10.2.2 BRIDGE DEFINITION

A bridge is defined as a structure spanning and providing passage over a river, chasm, road, or the like, having a length of 20 feet or more from face to face of abutments or end bents, measured along the roadway centerline.

10.2.3 STRUCTURE TYPES

Structure types include various culverts, slabs, box beams, and various types of deck girders, box girders, arches, and trusses. The selection of structure type is determined by the site, economic, environmental (in-water work windows, etc.) and esthetic considerations.

For small streams, a culvert might be used instead of a bridge. However, for locations with low deck-to-streambed clearances, a culvert may not be proposed because it could not provide enough waterway area. Fish passage issues may also influence the type of structure selected.

Concrete structures may either be pre-cast or cast-in-place. Pre-cast members offer the advantage of off-site fabrication (especially important in remote locations), speed of construction and minimal falsework. Pre-cast members can play a key role in Accelerated Bridge Construction, where it is important to minimize the impact of a construction zone on stakeholders. However, it may be difficult to accommodate horizontal curves, and change in gradelines or superelevations. Cast-in-place structures can more easily accommodate the geometrics. However, cast-in-place concrete requires falsework, which can create a traffic hazard at grade crossings and potentially cause problems at stream crossings.

The roadway designer needs to be aware that there are many types of structures with features that can compliment the specific site conditions. It is very important that the roadway designer and the structure designer communicate all of the site conditions to facilitate appropriate structure type selection.
10.2.4 STRUCTURE LENGTHS

10.2.4.1 ROADWAY CROSSINGS

Provide the required roadway horizontal clearances plus 1:2 end slopes for all bridges except for county roads or less-traveled highways. Use 1:1.5 end slopes for county roads and less-traveled highways per the Highway Design Manual. When using end slopes steeper than 1:2 a geotechnical review shall be completed to ensure stability.

10.2.4.2 STREAM CROSSINGS

1. Provide the required waterway opening to pass the specified design flood. The Hydraulics Report will provide a required waterway area, the stream bed elevation and the design flood high water elevation. Normally, a minimum bottom-of-beam clearance of 12 inches is provided above the design flood high water elevation. If drift or debris is a concern, the bottom of beam clearance will be increased.

2. Normally, overtopping is not desirable, but may be required to accommodate regulated hydraulic considerations.

10.2.5 STRUCTURE CLEARANCES

See Section 4.5 for additional information on all clearances.

10.2.5.1 VERTICAL CLEARANCE FOR HIGHWAY TRAFFIC

Proposed new construction that reduces vertical clearance shall require consultation with MCTD to ensure understanding of the impact of the proposed decrease to the user. All other projects, which result in final vertical clearances at or above the minimum vertical clearance, require notification of MCTD to ensure all vertical clearance inventories are current and updated for the appropriate routing of permit vehicles.

For projects other than new construction, no reduction of the existing vertical clearance below the minimum vertical clearance is allowed. No reduction in vertical clearance is allowed if the existing vertical height is currently below the minimum vertical clearance.

1. All High Routes the Vertical Clearances Standard is 17 feet-4 inches.
2. All non-High Routes on the NHS the Vertical Clearance Standard is 17 feet.
3. All non-High Routes and non-NHS the Vertical Clearance Standard is 16 feet.
4. Vertical clearances during construction below the minimums requires consultation with MCTD.

See the Vertical Clearance Policy Clarification and Refocus at http://www.oregon.gov/ODOT/HWY/docs/VertClear_amendedJuly08.pdf

10.2.5.2 HORIZONTAL CLEARANCES FOR HIGHWAY TRAFFIC

Normally the bridge roadway width will equal the approach roadway width plus 4 feet for bridge rail shy distance.

10.2.5.3 VERTICAL CLEARANCES FOR RAILROAD TRAFFIC

1. All new structures are to be designed with a minimum of 23 feet 6 inches vertical clearance.

2. A minimum vertical clearance of 21 feet (UPRR) or 21 feet-6 inches (BNSF) is required during construction.

10.2.5.4 HORIZONTAL CLEARANCES FOR RAILROAD TRAFFIC

1. The minimum clear distance from the center line of the track to a column face is 25 feet. This distance can be reduced to 18 feet if crashwalls are installed.

2. A minimum horizontal clearance of 12 feet (UPRR) or 15 feet (BNSF) is required during construction.

10.2.5.5 HORIZONTAL CLEARANCE DURING CONSTRUCTION

1. On Interstate Freeways the minimum width of 19 feet between face of rail for one-way/one lane traffic, plus additional clearance to falsework behind rails. Above 8 feet vertical on each side an additional 2 feet horizontal is required.

2. On non-Interstate highways the minimum width of 16 feet between face of rail for one-way traffic, plus additional clearance to falsework behind rails.

3. Minimum width of 28 feet between face of rail for two-way traffic, plus additional clearance to falsework behind rails.
10.2.6 CURBS AND SIDEWALKS

For a particular crash tested bridge rail, the curb or sidewalk height should be used as shown on the appropriate standard drawing.

10.2.7 DECK DRAINS

Some form of drainage system is normally needed on or off structures that have curb or concrete parapet rails. The Roadway Plans drainage details should be carefully reviewed. If drains are required, the project hydraulics engineer will do the design and determine the size and spacing. Bridge length, deck grades, cross slope, typical section, and deck surface type will be needed to determine the deck drain layout.

10.2.8 STRUCTURE SUPERELEVATIONS

The structure superelevation should match the roadway superelevation criteria. Structures are more susceptible to surface icing therefore superelevation rates may need to be limited to 8% or less in areas beyond the traditional snow/ice limits of the roadway superelevation criteria.

10.2.9 TRAFFIC CONTROL DURING CONSTRUCTION

There are four basic methods of handling traffic for replacing a bridge:

1. Close the highway while removing and rebuilding the bridge.
2. Use the existing roadway and bridge while constructing a parallel bridge on new alignment.
3. Construct a temporary detour bridge around the existing bridge and replace the bridge on the existing alignment.
4. Use stage construction with existing or new lanes carrying traffic while other portions of the existing bridge are being removed and rebuilt.

Another traffic handling consideration that should not be overlooked is accommodating pedestrians (including the disabled) and bicycles passing through the work site, especially in urban areas.
The proper type of bridge rail end and barrier treatment is dependent upon the location of treatment. Below is a listing of ways of treating bridge ends and barriers. Engineering judgement is still required when areas of treatment are other than normal.

1. Rural conditions, bridge rail end treatment: Use standard approach guardrail to bridge rail transitions. Apply at all rail ends inside the clear zone.

2. Urban conditions, bridge rail end treatment: Normally no approach rail is used when the design speed is 40 mph and below. In these cases, the end of the bridge rail will be protected by a tapered down concrete transition, even if the rail is at the back of a raised sidewalk and is outside the clear zone.

3. Ditch rider roads, bridge rail end treatments: When ditch rider roads are closer to the end of the bridge than standard transitions will allow, a crash-tested treatment shall be used. There is a minimum distance from transition to ditch rider road that allows this system to work, so judgement shall be used in those situations.
10.3 ENVIRONMENTAL STUDIES

10.3.1 PROJECT CLASSIFICATION

When a project is identified in the Statewide Transportation Improvement Program, (STIP) the responsible Region initiates a Project Prospectus, which includes Part 3, the Environmental Classification document. The Part 3 document gets attached to the final National Environmental Policy Act (NEPA) approval document and other required environmental clearance and approval documents as part of the FS&E Package submitted to Office of Project Letting (OPL). The Region recommends the environmental classification, Class 1, 2, or 3, and the Region Environmental Manager or designee signs the Part 3. FHWA makes the environmental determination and signs the final NEPA document (i.e., the CE\(^1\), Closeout, FONSI\(^2\), or ROD\(^3\)—for class 2, 3, and 1 projects respectively). A Programmatic CE (PCE) classified project does not need approval by FHWA, just concurrence.

Per FHWA, ODOT is required to document National Environmental Policy Act (NEPA) compliance for federal proposed actions. The NEPA document serves a federal purpose and therefore focuses primarily on compliance with federal statutes, regulations, and policies. ODOT is also responsible for adhering to state and local environmental and land use requirements, which are typically documented in the prospectus Part 3, and Environmental Baseline Report if required. These requirements exist for both state and federally-funded projects as relevant.

Most projects are Class 2 projects, which do not require an Environmental Assessment or Environmental Impact Statement, but may require specific environmental reports and/or mitigation and do require specific permits, approval and/or clearance documents which are attached to the CE Closeout Form package that FHWA must approve by signature. Class 1 projects will have a significant impact on the natural or human environment and require a draft and final Environmental Impact Statement (DEIS/FEIS) and the issuance of a Record of Decision (ROD). Class 3 projects that may have significant impacts to the natural or human environment require an Environmental Assessment/Revised Environmental Assessment (EA/REA) and a Finding of No Significant Impact (FONSI).

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1 Categorical Exclusion for Class 2 projects.
2 Finding of No Significant Impact for Class 3 projects. A FONSI is attached to the Environmental Assessment or the Revised Environmental Assessment if revisions are called for.
3 Record of Decision for Class 1 projects. The ROD is the final NEPA approval document for a project that has significant impacts and is therefore required to be analyzed in an Environmental Impact Statement or EIS—consisting of a Draft EIS (DEIS), a Final EIS (FEIS), and a ROD which captures the decision made and the rationale for making the decision. FHWA is the decision-maker for all NEPA documents.
Approving the CE Closeout Form, FONSI, or ROD by FHWA prior to PS&E allows the project to advance to the final design phase and to undertake right of way acquisition.

### 10.3.2 ENVIRONMENTAL STUDIES

The full spectrum of environmental impacts is evaluated for Class 1 and 3 projects and documented in a DEIS/FEIS (Class 1) or EA/REA (Class 3). Projects that are classified as Categorical Exclusions are evaluated to determine that there are minimal impacts, if any, and documented in the Part 3 of the Prospectus. Class 2 projects may also be documented in staff reports or documents focused on one environmental subject area. The level of detail required is driven by the nature of the impacts, not necessarily the class of the project.

The purpose of the environmental evaluation is to give information to the project team, the public, and the regulating agencies so that project decisions can be made by decision makers who are informed of all the consequences of the decisions they are making. It is hoped that this will lead to the solution that best balances transportation needs, safety, economics, and protects to the greatest extent feasible, the natural habitat and human environment.

ODOT Environmental Policy requires avoidance, minimization, and compensatory mitigation, in that order. All CE projects require a set minimum of environmental clearances, approvals and/or permits as stated in the Part 3 and CE Closeout Form regardless of whether resources exist or not, or whether there will be impacts or not (e.g., Cultural Resources, Endangered Species, and Tribal Consultation are the FHWA-required minimum clearance and/or approval documents). If federally-protected Parks or Recreation Areas are impacted, those clearances and/or approvals would be required as well, and there can be several other environmental clearances, approvals, and/or permits that are also required either before NEPA is approved or after—during final design and prior to bid let.

Designers should work very closely and as early in the project as possible with the Region Environmental Coordinator (REC) or EPM (Environmental Project Manager) for any questions or issues they may have with a particular design especially if the project is a Federal-aid Highway Program (FHWA-funded) or other federalized modernization, bridge, culvert, or safety project. These types of projects can be much more complex in addressing all the various aspects of environmental constraints and requirements if impacts cannot be entirely avoided. The REC or EPM coordinates with the Region or TLC environmental technical specialists working on the project, and is responsible to carry any messages related to design scope, schedule, or budget changes from environmental requirements to the Project Leader and PDT for further discussion if needed.

There are certain time-saving programmatic permits and agreements with various state and federal regulatory agencies available that are intended to cover certain projects without needing an individual permit or approval. It is crucial to coordinate with the Region REC or EPM along

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4 Technical Leadership Center—where Environmental Technical Specialists and Program Coordinators reside (within the Geo-Environmental Section).
5 Project Development Team.
with the other environmental specialists on the PDT to ensure the correct ‘environmental performance standard’ or ‘best management practice’ is being applied to the design in order to meet the relevant environmental standards as well as all the terms and conditions contained within individual permits if those are required. Environmental performance standards include specific design guidance that should be applied to projects that fit a certain category.

Since July 1, 2011, ODOT has been in the initial stages of using a newly developed Environmental Commitment Tracking System (ECTS). The system requires that all types of environmental commitments for all Project Classes are to be tracked and reported, included whatever environmental performance standards were applied to the project to meet regulatory requirements. It is a general tracking tool encompassing any type of commitment made by a project team to any regulator, organization, tribe, or other involved party that relates to environmental protection, mitigation, or enhancement. The Region RECs and EPMs are primarily responsible for entering commitments and maintaining the database.

### 10.3.3 SPECIFIC IMPACTS

Project impacts that affect the environment can be either direct or indirect as well as cumulative; occurring over time in addition to other similar impacts within a certain established area such as a watershed or ecosystem region. An example of a direct impact would be the removal of habitat by realigning the roadway prism. Indirect impacts often occur from changes in access. For example, providing an interchange where only an overcrossing existed may induce land use changes which, in turn, impact habitat. Other indirect impacts can occur from increasing development that can result from improvements made (i.e., the projects) to the transportation system. These are more difficult to predict with certainty, but are often the more profound impacts. Either type of impact can influence the facility design as the project team attempts to avoid, minimize or offset/mitigate the impacts. Typical of some of the impact areas are:

#### 10.3.3.1 NOISE

Noise barriers may be used to mitigate traffic noise on a project. The preliminary design (location, height, length) for these barriers is done by the noise analyst (consultant) conducting the technical work for the noise study. After the barrier has been determined to be feasible and reasonable, the affected residents and property owners must vote their approval before the wall can be built. The public involvement process may also be used to help determine the type and the surface features (if any) of the wall and desirability of a noise barrier.

The final decision as to the type of noise barrier to be constructed will be made during the final design process. The project structural designer will do the final design of the structural element of a noise wall often times working with the noise analyst who did the preliminary design to ensure effectiveness of the final wall location and dimensions. The project roadway designer will do the final design of an earth berm.
It is essential to realize that additional right of way may be necessary to construct the footings for a wall. In addition, conflicts can arise between a noise barrier’s location and utilities, signing or drainage facilities. Coordination during the final design process involving all of the affected groups will help in avoiding conflicts with wall placement.

10.3.3.2 HISTORIC

Environmental law requires that all buildings, objects, sites, structures (i.e. bridges/tunnels) or districts (i.e. historic roads, railroads) listed in or eligible for listing in the National Register of Historic Places be avoided, or if part of the transportation system, are minimally affected. These are known as Section 4(f) properties.

10.3.3.3 ARCHAEOLOGY

Archaeological sites are frequently identified on our projects and can influence engineering/design. The archaeological site type, depth, and location may require special protections and sometimes even warrant preservation in place. For example, archaeological sites are frequently found at stream crossings and confluences; they can be deeply buried or relatively shallow. Such sites may require special re-designs to avoid the locations. In addition, some Tribes continue to use certain site locations for ceremonial practices; in those cases a project may require special engineering/design for access points. Designating no-work zone areas is also typical. Successful design alternatives can be reached by working closely with the Project RECs and ODOT Archaeologists and through consultation with the Native American Tribes.

10.3.3.4 WETLANDS

All classes of projects frequently impact wetlands. It is critical to determine if there are alternatives that avoid the impact, and if not, how the impact can be minimized or mitigated, in that order, for all wetland areas. Different alignments, steeper slopes, retaining walls, and other techniques must be used to avoid or reduce impacts, if these techniques are feasible in the impact area.

10.3.3.5 WATER QUALITY

Designs that can avoid disturbance of water quality, including changes to an area’s hydrology, are important to consider. Stormwater management for water quality is required for projects that:

1. Increase impervious surface area,
2. Change highway alignment and/or modify the storm drainage system including adding curbing to current uncurbed sections of roadway,

3. Replace or widen stream crossing structures (bridges, culverts, etc.), or

4. Do extensive reconstruction of the roadway by removing and replacing the pavement.

Water quality treatment is to be designed to treat all of the runoff from the project’s Contributing Impervious Area (CIA) resulting from the Water Quality Design Storm. Treatment techniques that incorporate infiltration, media filtration and filtration through vegetation are considered to be highly effective at removing highway pollutants thereby maintaining and/or improving water quality. Further information on what triggers the requirement for treatment of stormwater is found in Geo/Environmental Technical Bulletin 09-02(b). Information on the Water Quality Design Storm and treatment techniques is available in the ODOT Hydraulics Manual.

Flow control is required for projects that increase discharges to a surface water by more than 0.5 cfs from the 10-year 24-hour storm, and which do not discharge into a large water body (river, lake, reservoir, estuary, ocean). The intent is to prevent adverse changes to stream stability and form by matching the post-project to the pre-project hydrology for the range of flows most responsible for stream channel processes and erosion. Detailed information on the range of flows is found in Geo/Environmental Technical Bulletin 09-02(b) and in the ODOT Hydraulics Manual.

10.3.3.6 THREATENED AND ENDANGERED (T&E) SPECIES

Many projects have the potential to impact wildlife in general and T&E plant and animal species more specifically. In this case, design changes to avoid impacts are required. Conservation measures are often required as part of the construction contract to avoid impacts to protected species. Since these vary widely with the various species, it is important to work closely with the Region biologist and/or Local Agency consultant biologist when designing the facility and work conditions near endangered and threatened species, particularly near fish bearing streams and wildlife groups.

Seasonal in-water work periods are designated for most Oregon waterways; stream classification and fisheries activity can also influence the design of most bridge and culvert replacement and larger transportation improvement projects. Due to the presence and/or likelihood of T&E species and/or critical habitat in many areas of the state, water quality requirements to protect species and in-water work timing prompt critical project discussions between designers and environmental specialists. Designs that can avoid in-water work or disturbance of water quality, including changes to an area’s hydrology, are important to consider.

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\[6\] The Water Quality Design Storm is 50% of the 2 year 24 hour storm for climate zones 1, 2, 3, 6, 7 and 8, 67% of the 2 year 24 hour storm for climate zones 4 and 9, and 75% of the 2 year 24 hour storm for climate zone 5.
10.3.3.7 MIGRATORY BIRD TREATY ACT

Many projects have potential to violate the Migratory Bird Treaty Act and should be reviewed by regional environmental coordinators. Activities which are most likely to impact and result in take of migratory birds on highway projects include, but are not limited to; clearing or grubbing of migratory bird nesting habitat during the nesting season when eggs or young are likely to be present, bridge cleaning, painting, demolition, or reconstruction where bird nests are present. Proper coordination with regional environmental coordinators will help prevent projects from being halted or delayed due to bird issues.

10.3.3.8 AIR QUALITY

Transportation plans, programs and projects within Oregon’s nine air quality non-attainment and maintenance areas must conform with the intent of the State Implementation Plan (SIP) for air quality. Major projects in these areas requiring DEIS/FEIS or EA/REA environmental documentation must demonstrate conformity before FHWA can issue a ROD or FONSI. Smaller projects involving signalization, channelization, changes in vertical or horizontal alignment or bus terminals may also require a conformity determination. An air quality specialist should be consulted when questions arise regarding specific conformity requirements in the following areas: Portland Metro, within the METRO Urban Growth Boundary (UGB), Salem-Keizer Area Transportation Study, Eugene-Springfield UGB, Medford-Ashland Air Quality Maintenance Area, Grants Pass UGB, Klamath Falls PM2.5 boundary, La Grande UGB, Lakeview UGB and Oakridge PM2.5 boundary.

10.3.3.9 HAZARDOUS MATERIALS

All projects need to be reviewed for potential impacts to hazardous material sites. There are many risks that can be created or aggravated even when working completely on ODOT right of way. When excavating or working along ditches the designer must be careful of disturbing contamination or causing lateral transport of that contamination, and the design must manage contaminated material, transport, and surface drainage.

All projects require a Pollution Control Plan. The plan will address the contractor’s response in the event of an unforeseen spill, leak, or discovery.

New federal policies stress that the State needs to consider future land uses when deciding the location of facilities. It is not necessary to try to avoid all contamination. The contaminated site could be used for transportation, which could to bring the site into greater productivity.
10.3.3.10 OTHER AREAS

Project impacts to floodplains, scenic resources, emergency services, neighborhoods, social and cultural interactions, businesses and other environmental subject areas can be of sufficient importance to influence the design. Land use and planning, particularly compatibility with comprehensive plans, Department of Land Conservation and Development Statewide Planning Goals, and requirements of the Transportation Planning Rule, are critical elements in determining the design of the facility.

10.3.3.11 PERMITS

Many of the above areas will require individual environmental permits (see Section 10.9), if the project cannot meet the available programmatic permit requirements that ODOT currently has in place with several regulatory agencies. The Region REC or EPM is the best source for designers to determine if and when individual environmental permits and other individual approvals are needed.

10.3.4 DESIGN SPECIFICATIONS

A summary of mitigation and conservation measures, known as ‘environmental commitments’, is included in the CE Closeout Form, REA, or FEIS for the specific project. These environmental commitments are incorporated into the plans and specifications for the project. Although there are some standard conservation measures listed in the “Oregon Standard Specifications For Construction - 2008”, project specific items are identified in the CE Closeout Form, REA, or FEIS.

As stated previously, the Region REC or EPM for a specific project should be consulted early in the project’s design on questions regarding all environmental commitments.

10.3.5 PLANS, SPECIFICATIONS AND ESTIMATE (PS&E)

Approximately 7 weeks prior to bid letting, the PS&E package - which includes the required NEPA approval document and all environmental clearances, approvals, and permits - is delivered to the Office of Project Letting (OPL) for final processing. All NEPA approvals and other environmental permitting work must be completed at this point.
10.4 GEOTECHNICAL DESIGN

10.4.1 GENERAL

Two of the many questions faced by the highway designer include:

1. What are geotechnical project elements; and
2. How should they be dealt with?

Geotechnical project elements include all issues of design and construction involving soil and rock. How to deal with geotechnical project elements is a more complicated question. Since almost every highway project uses either earth or rock as a construction material and relies on earth support, subsurface information and geotechnical data is essential for project planning, design, and construction. Any geologic feature or material that affects the design and construction phase of a project, or has a bearing on site or corridor selection in terms of hazards or economics must be investigated and analyzed. Of equal importance is the clear and accurate portrayal of these conditions in a format that is accessible and understandable by all users.

The purpose of this section is to make the highway designer aware of the broad range of geotechnical issues that may need to be addressed, and their potential effects on any project regardless of size or apparent complexity. There are common project elements that typically require site-specific geotechnical investigation and design such as bridge foundations and landslide mitigations, and there are project elements that, depending on the site history and underlying geology, may or may not need a site-specific geotechnical investigation and design, or may require different levels of effort. The geotechnical designers will be able to determine the level of effort based on their own or other’s knowledge and experience of the site to make these judgments. Because of the underlying site conditions, elements that generally don’t warrant geotechnical design for most sites may require it at others. Conversely, investigation and design efforts may be scaled back or eliminated at other sites due to known favorable conditions, and the significance of the project feature. It is the geotechnical designer’s responsibility to make these decisions.

The guidance provided in this section is not exhaustive as every project is unique. The ODOT Geotechnical Design Manual (GDM) must be consulted for all geotechnical design elements and is available at the following weblink: ftp://ftp.odot.state.or.us/techserv/Geo-Environmental/Geotech/GeoManual/FinalGDMApril2011/FinalGDMApril2011.pdf

10.4.2 COMMON GEOTECHNICAL DESIGN ISSUES

The following is a list of the geotechnical issues common to highway projects of almost any size:
10.4.2.1 SELECTING AND DESIGNING STABLE SLOPES FOR CUTS AND EMBANKMENTS

This far ranging issue must consider the materials available or required for construction, the space available to make the slopes, erosion from the slope, picking slopes to minimize maintenance, how the slopes will be constructed, surface drainage over the slope, and quality control to insure good performance. The subject also includes designing steeper than usual slopes to accommodate right of way limitations, avoid environmental features, or simply save money. Many options can be used to build steep slopes ranging from specially placed select materials to geosynthetic reinforcement.

10.4.2.2 AVOIDING OR DEALING WITH UNSTABLE OR POTENTIALLY UNSTABLE SLOPES

This deals with the broad subject of building on or around landslides or not creating landslides with earthwork construction. Both cuts and fills may be involved. The subject also includes the possibility of destabilizing an existing fill by making changes to it including widening or slope steepening. Special design is usually necessary to recognize and deal with this issue.

10.4.2.3 EMBANKMENTS OVER SOFT FOUNDATIONS

An embankment on soft ground often settles dramatically and may slide, slump, or sink during construction if not designed properly. It is important to know how much settlement will occur and how long it will take to finish. Often, measures must be taken to accelerate settlement or improve foundation strength. Options include flat slopes, berms, stage construction, surcharging, wick drainage, foundation reinforcement, ground improvement and lightweight embankment materials.

10.4.2.4 MATERIALS FOR CONSTRUCTION

On-site soils must generally be used for economy but they may be poorly suited for embankment construction. Soil type and excess moisture are often problems. Wet soils and strategies for dealing with them must be recognized. Finding suitable sources for borrow can be important. Also under this heading are design strategies for getting embankment built over wet, soft subgrade, or building embankment in wet weather. Other issues may include the presence of boulders, rock, or other obstructions in excavation and the proper placement and compaction of soil, soil rock mixtures, and rock fills. Special density testing and compaction requirements will often be required for special cases including embankments with steep slopes, high embankments, or fills in critical locations.
10.4.2.5 WIDENING CUTS AND FILLS

Projects involving widening must be carefully considered to assure that cuts and fills will perform well and can actually be constructed. Sliver cuts and fills can be and often are severe construction problems. There are also issues around the type of fill used in a widening and whether certain material may actually destabilize an existing embankment by causing water to backup in the old fill.

10.4.2.6 EARTHWORK BALANCE ANALYSIS

On moderate to large projects, estimating the volume shrinkage or swell of earth and rock material from borrow to embankment can be a major source of error in balancing the earthwork. A careful consideration of the volumes of material along with evaluation of the earth density can be used to refine shrink/swell estimates.

10.4.2.7 SURFACE AND GROUNDWATER CONTROL

Water control is necessary for stable slopes.

10.4.2.8 SEISMIC SITE RESPONSE AND MITIGATION DESIGN

Consideration will be increasingly given to the seismic stability of embankments and slopes. A key issue is the liquefaction of embankment foundations.

10.4.2.9 ROCK SLOPES

In designing new alignments or widening in rock, the issue is the appropriate slope and its configuration to minimize rockfall. Some projects may require improvements in existing rock slopes to minimize the impacts of rockfall. Design guidance is provided later in this document.

10.4.2.10 PAVEMENT SUBGRADE

The Pavement Unit deals with this issue to determine if wet soils will make pavement construction difficult.

The above list is not exhaustive as every project is unique. The GDM must be consulted for all geotechnical design elements.
10.5 HYDRAULICS

10.5.1 GENERAL

The ODOT Hydraulics Manual must be used to design highway drainage features to convey both subsurface and surface water under, along, or away from the highway. These facilities must be economical and efficient, and they must convey the discharge without damaging the highway or endangering the public. Also, all designs must comply with the Oregon Drainage Law, Federal Clean Water Act, and other applicable environmental regulations. A hydraulic engineer in the Region Technical Center or the Geo-Environmental senior hydraulics engineer should be contacted for assistance about project specific drainage issues.

A drainage plan with design calculations is part of the design data that must be prepared on all projects. The project roadway engineer usually prepares the drainage plan. The drainage plan must address the location, size, and alignment of inlets, storm drains, small culverts, pipe materials, outlet protection for small pipes, roadside ditches, and cutoff ditches. The drainage plan must be reviewed by another roadway designer or the project hydraulics engineer prior to finalizing the drainage plan.

ODOT Hydraulics Manual Chapter 13 provides guidance for standard stormwater designs. Standard stormwater designs include roadway inlets, small storm drains and small channels or ditches. This information is part of the drainage design provided to the roadway designer who incorporates the drainage features into the roadway design. It also may be part of the work done by the roadway designer if the drainage and roadway designs are done concurrently.

A hydraulic and/or a stormwater report will be required to document significant bridge, culvert, storm drain, and water quality and storage facilities. These reports are prepared by the project hydraulic engineer. See ODOT Hydraulics Manual Chapter 4 for documentation guidelines.

10.5.2 DESIGN CONSIDERATIONS OF DRAINAGE STRUCTURES

1. Determine the natural points of concentration, discharge and other hydraulic controls.
2. Provide for removal of detrimental amounts of surface water.
3. Determine either the area of net new impervious surface added by the project or the total contributing impervious area. Which area used is dependant on the drainage structure type.
4. Provide the most efficient drainage, water quality, and/or detention facilities consistent with cost, maintenance, economy and legal obligations.
5. Determine environmental and biological constraints.
6. Provide cost effective design of bank and embankment protection features.

10.5.3  ECONOMIC AND LEGAL ASPECTS THAT MUST BE CONSIDERED DURING DRAINAGE DESIGN

1. Cost of construction and right of way.
2. Effects on adjacent property, particularly with respect to State liability.
3. Interference with traffic including road closures or detours.
4. Water in natural channels diverted from its usual course.
5. Water diverted or discharged over land or through a watercourse that would not normally receive such waters.
6. Peak surface runoff increased and discharged to water bodies that would not normally receive such peak flows.
7. Percolating waters intercepted and diverted for the protection of the highway.
8. The use of infiltration for disposing of water into soils and subsequently groundwater must be registered with the Oregon Department of Environmental Quality and is required to be monitored.
9. Maintaining hydraulic conditions within an adopted floodway according to Federal Emergency Management Agency (FEMA) regulations.

10.5.4  OREGON DRAINAGE LAW

Oregon drainage law, which originates from common law or court-made law, has developed without legislative action, and it is embodied in the decisions of the courts. Therefore, there are no Oregon Revised Statutes to cite pertaining to Oregon drainage law.

Oregon has adopted the civil law doctrine of drainage. Under this doctrine, adjoining landowners are entitled to have the normal course of natural drainage maintained. The lower owner must accept water that naturally comes to his land from above, but he is entitled not to have the normal drainage changed or substantially increased. The lower landowner may not obstruct the runoff from the upper land if the upper landowner is properly discharging the water.

For a landowner to drain water onto lands of another in the State of Oregon, one of two conditions must be satisfied initially:

1. The lands must contain a natural drainage course; or
2. The landowner must have acquired the right of drainage supported by consideration (i.e., a purchased drainage easement).
In addition, because Oregon has adopted the civil law doctrine of drainage, the following three basic elements must be followed:

1. A landowner may not divert water onto adjoining land that would not otherwise have flowed there. "Divert water" includes but is not necessarily limited to:
   (a) Water diverted from one drainage area to another; and
   (b) Water collected and discharged which normally would infiltrate into the ground, pond, and/or evaporate.

2. The upper landowner may not change the place where the water flows onto the lower owner's land. (Most of the diversions not in compliance with this element result from grading and paving work and/or improvements to water collection systems.)

3. The upper landowner may not accumulate a large quantity of water, then release it, greatly accelerating the flow onto the lower owner's land. This does not mean that the upper landowner cannot accelerate the flow of water at all; experience has found the drainage to be improper only when the acceleration and concentration of water were substantially increased.

Subsurface waters which percolate to the surface can be intercepted and diverted for the protection of the highway without regard for the loss of these waters to the adjacent landowners. In those cases where wells and springs are involved, the right of way agent should contact the affected owner(s) to prevent any misunderstanding over damage that could be claimed. Drainage designs should satisfy Oregon drainage law to avoid claims or litigation resulting from improper drainage design. When it is apparent that the drainage design will not satisfy the law, then drainage easements should be obtained from the affected property owners. The legal staff should be consulted in those situations that appear to be unique and could result in litigation.

Where certain drainage patterns have been established over long periods of time (i.e., in excess of at least 10 years), that are not the original natural drainage, there may be legal rights acquired which allow the continuance of the altered drainage pattern. Again, legal staff should be consulted in such situations.

Oregon drainage law is discussed further in the ODOT Hydraulics Manual.

### 10.5.5 COOPERATIVE PROJECTS

Participation in cooperative projects for flood control and/or flood protection mitigation, and/or water quality treatment must be approved by the Regional Technical Center with the extent of participation being restricted to the amount of benefit accruing to the Oregon Department of Transportation. No commitments should be made prior to approval by the Regional Technical Center and the amount of participation shall be documented by formal agreement. Actual work performed by ODOT under such agreements shall be limited to highway right of way unless otherwise approved in advance by the Regional Technical Center.
Projects should consider opportunities for regional stormwater management facilities as appropriate in conjunction with city or county projects.

### 10.5.6 HYDRAULICS REPORT

The hydraulics report is prepared by the project hydraulics engineer. This is the final report that provides detailed information for many tasks, such as structure design, roadway design, environmental documents, and permit applications. This report would detail the hydraulic recommendations for:

1. Bridges
2. Large culverts 48 inches in diameter or larger
3. Floodplain/Floodway analysis
4. Fish passage
5. Scour protection
6. Streambank stabilization
7. Outlet protection of open channels or closed conduits such as culverts or storm drains.

### 10.5.7 STANDARD STORMWATER DESIGN DOCUMENTATION OR STORMWATER REPORT

Standard stormwater design documentation can be prepared by the project roadway or hydraulics design. ODOT Hydraulics Manual Chapter 13 provides guidance for standard stormwater designs. Standard stormwater designs include roadway inlets, small storm drains and small channels or ditches. This information is part of the drainage design provided to the roadway designer who incorporates the drainage features into the roadway design. It also may be part of the work done by the roadway designer if the drainage and roadway designs are done concurrently.

A stormwater report will be required to document significant storm drain and water quality and storage facilities. The documentation for these projects is greater than the standard stormwater design documentation. These reports are prepared by the project hydraulic engineer. See ODOT Hydraulics Manual Chapter 4 for documentation guidelines. The facility design(s) incorporated in the final plans should comply with the information in the stormwater report. A stormwater report will detail the design recommendations for:

1. Storm drain systems with pipes larger than 24 inches in diameter
2. Stormwater control facilities including detention, retention, split-flow structures, etc.
3. Stormwater water quality
The types of design information that may be in the stormwater report include the following:

1. Inlet spacing
2. Storm drains
3. Culverts, small, less than 1200 mm in diameter
4. Detention
5. Water quality
6. Outlet protection
7. Roadside ditches
8. Cut-off ditches

10.5.8 DESIGN FEATURES

10.5.8.1 FLOODWAYS

The National Flood Insurance Program has established floodways on many rivers and streams in Oregon. A floodway is the regulated portion of the stream channel plus portions of the adjacent floodplain where encroachment is prohibited or limited. The remaining portion of the floodplain that is not included within the floodway boundaries, known as the floodway fringe, is often suitable for encroachment. The regulations require the areas within the regulated floodway to be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood stage or elevation. Minimum standards of the Federal Emergency Management Agency (FEMA) limit such increases in flood stage in the floodway to no more than 1 foot, provided hazardous velocities do not result. In some instances, community officials have adopted a floodway that allows less than a 1 foot rise. Highways adjacent to or crossing floodways should be designed to maintain the existing floodway conditions, if practicable. Floodway boundaries can be determined by consulting the appropriate Flood Insurance Study or the project hydraulics engineer. The project hydraulics engineer should be contacted for assistance as soon as it has been determined that a floodway or floodplain exists within the project limits, before any work in the floodway or floodplain is considered.

In some cases it may not be practicable to construct a project without modifying the existing floodway boundary. A floodway boundary revision request or other documentation must then be submitted to and approved by FEMA. This process may require up to 12 months to complete. FEMA approval of requests for floodway revisions are normally obtained by the local jurisdiction; either the City or County. In other cases temporary construction (such as work bridges, cofferdams, etc.) is needed to construct the project within the floodway. The project hydraulics engineer provides the engineering analysis necessary for projects to conform to the local floodplain regulations. Additional information on the National Flood Insurance Program and floodways can be found in the ODOT Hydraulics Manual, Chapter 2.
10.5.8.2 BRIDGES

The project hydraulics engineer provides the engineering analysis for bridge replacements over waterways. Information on Bridge Hydraulics can be found in the ODOT Hydraulics Manual, Chapter 10.

10.5.8.3 SCOUR AND STREAMBANK PROTECTION

Scour can occur around bridges, along river bottoms, and along roadway embankments and can lead to catastrophic failure of structures, embankments, and roadbeds. When this scour becomes critical it is necessary to correct the eroded areas and provide protection from future scour. The project hydraulics engineer prepares and/or reviews all proposed solutions for scour mitigation. Information on scour and bank protection can be found in the ODOT Hydraulics Manual, Chapter 10 and Chapter 15.

10.5.8.4 INLET SELECTION

Storm drain inlets are used to collect surface runoff and discharge it to an underground storm drainage system. Inlets are typically located in gutter sections, paved medians, roadside ditches, and median channels. Inlets used for the drainage of highway surfaces can be divided into five classes:

1. Grate inlets
2. Curb-opening inlets
3. Slotted drain inlets
4. Combination inlets, and
5. Trench drain inlets

Inlets recommended for traffic areas include:

- G1 - Single Grate
- G2 - Double Grate
- CG1 - Single Grate plus curb opening
- CG2 - Double Grate plus curb opening
- CG3 - Curb Opening only

The performance of inlets and cross slope has an impact on hydraulic capacity. In a past study, the performance of the CG-3 curb opening inlet was compared to the standard grated inlets. The study ignored the curb opening portion of the CG1 and CG2 inlets in the calculations; this provides additional safety factor in the analysis for these inlets.
The efforts of the study provided the following results:

<table>
<thead>
<tr>
<th>Gutter Grade</th>
<th>Inlet Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 8%</td>
<td>CG-2 and G2 are acceptable</td>
</tr>
<tr>
<td>&lt; 1%</td>
<td>CG-3 more efficient than CG-1 and G1</td>
</tr>
<tr>
<td>&gt; 1%</td>
<td>CG-3 not recommended</td>
</tr>
</tbody>
</table>

In summary the study concluded that the CG-3 curb opening inlets are cost effective when the gutter grade is less than 1%.

Slotted drain inlets are cost effective and efficient inlets, but create challenges for maintenance. The slotted drainpipe should be evaluated in the same manner as other pipes (i.e., minimum cleanout velocity = 3 ft./s). This translates to providing a minimum slope of 0.89% for an 18 inch and 1.5% for a 12 inch diameter corrugated pipe. It is not recommended to place slotted drain inlets in sags unless a tapered slot is provided. Due to the tendency of these inlets to plug, assume 50% clogging and provide twice the calculated required length for flow interception.

Trench drain inlets are long and thin like slotted drains but include small removable grates that provide maintenance access and a sloped bottom so they can be installed in pavement on any slope. Trench drain inlets should not be used in areas with high speed traffic.

10.5.8.5 STORM DRAINS

Roadway drainage often includes inlets and storm drains to convey runoff collected by the inlets. Each inlet should be checked for efficiency and capacity. Each pipe should be evaluated for structural integrity, capacity and outlet protection. Design of inlets and storm drain pipes included in the Drainage Plan is usually prepared by the project roadway engineer. The drainage plan must be reviewed by another roadway designer or the project hydraulics engineer prior to finalizing the drainage plan. Storm drain design guidance is provided in ODOT Hydraulics Manual Chapter 13. Design analysis documentation guidance is discussed above and in ODOT Hydraulics Manual Chapter 4.

10.5.8.6 CULVERTS

All culverts should be evaluated for structural integrity, capacity and outlet protection. An existing culvert should not be extended without first conducting a thorough evaluation of the pipe’s structural integrity. Pipe rehabilitation or replacement may be required if the culvert has exceeded its service life. Culverts with diameters 48 inches or larger should be designed by the project hydraulics engineer and are considered “Large” culverts. “Small” culverts are smaller 48 inches. Refer to Chapter 9 in the ODOT Hydraulics Manual for design policy and procedures. A
culvert Design Sheet (a sample is available in the Hydraulics Manual) or equivalent computer hydraulic modeling, should be prepared with the design data.

10.5.8.7 FISH PASSAGE

It should be assumed that fish passage will be required at all proposed highway-stream crossing projects regardless of stream size unless told otherwise by the ODOT Region Environmental Coordinator. If fish or wildlife passage is necessary, the project hydraulics engineer should be consulted for the replacement or retrofit evaluation and design, if required. Information on design for fish passage is located in the ODOT Hydraulics Manual, Chapter 9.

10.5.8.8 PIPE MATERIALS

Concrete, metal, and various types of plastic pipes are available for use on projects. The site conditions and design criteria will determine which materials are viable options. Alternate materials that are viable for use at a particular site are required to be allowed. The contractor will supply the most economical product from the allowable alternatives.

The use of metal pipes is an excellent economical choice provided that care is taken regarding the material that used for foundation and backfill. Soil samples must be taken at the site where metal pipes might be used to measure soil and water pH and resistivity.

Lack of care in the determination of gauge size and/or coating of metal pipe can lead to catastrophic failure in relatively short time frames. The following photo shows a sink hole developed 2 years after the metal pipe was installed due to corrosion.
Sinkhole in metal pipe 2 years after installation

During the field survey, soil samples will be taken at each site and of backfill soil that may be used. If there is evidence of corrosion in other metal pipes handling the same stream flow, water samples will be required. If the foundation soil changes significantly throughout the length of the pipe, or if the backfill material shows evidence of variability, adequate samples of foundation material and backfill material will be required.

Samples will be sent to the ODOT Engineering Laboratory in Salem or a qualified testing facility for testing. A sample should weigh 9 to 15 pounds, and may be submitted in either a heavy plastic or canvas bag. The sample data sheet must show the station, anticipated pipe size, whether the material is for foundation or backfill, and any appropriate comments about the condition of metal pipes in the vicinity.

Plastic pipes are an excellent economical alternate material. Particular care must be given to the end treatment used in culvert applications. Sloped ends of corrugated High Density Polyethylene (HDPE) require additional end treatment to prevent the folding up of the inlet end of the pipe in normal storm events. Removing the top section of the pipe to make the sloped end reduces the strength of the material to resist the upward buoyancy force of the pipe as water accumulates at the inlet end of the culvert. Solutions to this problem are to use either a paved end slope or install a metal end piece when plastic pipes are allowed and a sloped end is required.
Untreated sloped end lifted after normal rain event

See ODOT Hydraulics Manual for information about alternate materials policy and design instructions for pipe material selection.

**10.5.8.9 DETENTION**

Detention may be necessary to limit peak runoff if existing drainage facilities used for stormwater conveyance are not sized adequately for estimated peak flows, if the project increases peak flows to a quantity-limited waterway, or in accordance with an approved drainage master plan. All detention facilities must be reviewed or designed by the project hydraulics engineer. Refer to Chapter 12 of the ODOT Hydraulics Manual for guidance on project requirements and design guidance.

**10.5.8.10 WATER QUALITY TREATMENT**

Most projects must address water quality. The water quality goal is considered to be met if the following design criterion is met:

1. Treatment is provided for all of the runoff generated by the Water Quality Design Storm from the Contributing Impervious Area using Best Management Practices that utilize infiltration, media filtration or vegetative filtration.
It is not always possible to meet this criterion. The goal can still be met by taking alternative actions, including off-site mitigation, that provide a similar water quality benefit.

Projects that include the following “trigger” elements are required to provide treatment of highway runoff:

1. Producing new impervious surface area. Does not include:
   (a) Minor actions such as constructing sign or signal post pads, etc., or
   (b) Non-pollutant generating areas such as detached bike paths and detached sidewalks
2. Changing the total Contributing Impervious Area.
3. Re-constructing a roadway from the subgrade. Does not include pavement overlays or inlays, or spot reconstruction.
4. Changing the type, location, direction, length or endpoint of the pre-project stormwater conveyance system.
5. Replacing or widen a stream crossing structure including adding new bridge decks or retrofitting bridge deck drainage.
6. Requiring a Clean Water Act Section 404 permit and actively involving modification of impervious surfaces.

Some projects will require specially designed treatment facilities while other projects will only require implementation of best management practices (BMPs). The Roadway Designer must provide the project’s contributing impervious area to the Water Quality Specialist in the Environmental Section. This information will be used to help determine treatment requirements. Various local jurisdictions have special requirements that must also be addressed. All water quality facilities must be reviewed or designed by the project hydraulics engineer. Refer to PDLT Notice 05 (PD-05) and Chapter 14 of the ODOT Hydraulics Manual for guidance on project requirements and design guidance.

10.5.8.11 OUTLET PROTECTION

Protection should be provided at pipe outlets to minimize local scour caused by concentrated flows and high flow velocities. Typical outlet protection utilizes a rip rap pad sized sufficiently to dissipate the energy from the end of the pipe into sheet flow. Environmentally sensitive locations may require larger transition areas and planting. The outlet protection for pipes 48 inches or larger should be reviewed by the project hydraulics engineer.

10.5.8.12 ROADSIDE DITCHES

Roadside ditches should be provided to convey roadway runoff where storm drain systems are not appropriate. Roadside ditches should also be designed to prevent saturation of the roadway base material. This can be accomplished by requiring the water surface elevation in the ditch to
not exceed the elevation of the bottom of the base material. A typical roadside ditch should be sized for capacity and stability in addition to water quality treatment.

The peak discharge, longitudinal slope, and ground cover for each ditch affect the ditch capacity. On steep slopes shear stresses on the ditch bottom should be evaluated to assure the ditch does not erode. The discharge contributing to ditches runs off from areas from within the right of way, but this area is often small compared to runoff from outside the right of way. Evaluate each ditch for significant flows from off-site. The standard 6 inch deep ditch should be used on all projects unless the calculated peak flows indicate insufficient capacity or instability. Water quality mitigation requirements may require a 4 foot wide flat bottom ditch or wider be used to provide BMP level treatment.

Shear stresses will be less in ditches not flowing full. The information on stability for cohesive and non-cohesive soils include a range of values because soil properties such as plasticity and gradation vary considerably and can significantly affect how the soils react to shear stresses in the bottom of the ditch. For more information refer to the ODOT Hydraulics Manual, Chapter 8.

10.5.8.13 CUT-OFF DITCHES

Cut-off ditches should be provided above higher erodible cuts to convey drainage of surface water away from the face of the cut. They should be set back about 10 feet from the top of cut slope.

10.5.8.14 DESIGN DEVIATIONS

If a proposed hydraulic design can not meet requirements as defined in the ODOT Hydraulics Manual - 2011 for the following items listed, then a design deviation shall be required.


See ODOT Hydraulics Manual - 2011 Chapter 3 Appendix A for the deviation form.

A. Design Frequency: [Design Flood]

The recurrence interval of flood for which the drainage structure is sized; to assure no traffic interruption or significant damage will result. The following issues are of particular concern when evaluating exceptions to the design standard.
1. General
   (a) Significant Increase of flood hazard for property

2. Cross Drainage
   (a) Overtop Highway, or
   (b) Exceed a certain depth on the highway embankment (see allowable headwater)

3. Storm Drains
   (a) Encroach on the street or highway so as to cause a significant traffic hazard, or
   (b) Limit Traffic, emergency vehicle, or pedestrian movement to an unreasonable extent.

B. **Design Spread:**

The width of storm water flow in the gutter measured laterally from the roadway curb.

- Reflects public expectation for finding water on the pavement surface
- Is related to design speed and safety concerns with hydroplaning

C. **Allowable Headwater:**

The depth of water that can pond at the upstream end of a culvert during the design flood.

- Stability of roadway embankment. Most roadway embankments are designed and constructed without saturation of embankment materials or lateral forces considered - they are not designed as dams
- Upstream and downstream impacts relating to erosion and flooding.
10.6 PAVEMENT

10.6.1 GENERAL

The pavement design for each project will be determined by the Pavement Design Group. Because the depth of surfacing is a major factor in the project design and cost, the pavement design is needed early in the project development process. If the Pavement Design Group is to complete their design work on time, keeping them informed of any changes in the project scope and schedule is very important.

The primary function of the Pavement Design Group is to provide the most practical and cost-effective pavement/base/subgrade design for the conditions and criteria for a specific project. Development of the design is accomplished through a combination of field investigation, data analysis, and application of appropriate design procedures. Pavement design procedures and ODOT Policies are outlined in the ODOT Pavement Design Guide. The surfacing type selection, such as PCC versus AC, will be the responsibility of the Pavement Design Group and will not be left to the competitive bidding process.

10.6.2 PROJECT SCOPE

Before the pavement design process can be started, the project scope must be established. Once the project scope is established, the Pavement Designer can begin the field investigation. Because of the limited availability of the Pavement Design Field Crew and other factors, scheduling fieldwork several months prior to the date when a complete design is necessary is important. Any changes in the project scope could require additional field work and should be brought to the attention of the Pavement Designer as soon as possible.

Field work for most projects will involve deflection testing of the existing road surface. This work cannot be performed when the existing pavement or subgrade is frozen. For this reason field work for projects in frost susceptible areas needs to be completed during the summer prior to the time a design is required. This may in some instances (particularly for Regions 4 and 5 and projects at the higher elevations in the Cascades) require the scope and project schedule to be finalized eight to nine months in advance of the time a pavement design is required. Typically, if a pavement design for a project in the above areas is needed prior to July of a given year, a work request needs to be provided by August of the previous year.
10.6.3 DESIGN CONSIDERATIONS

Additional information important in the selection of the most appropriate pavement design for a particular project is listed below.

- The availability of materials
- Source of embankment materials
- Traffic staging details*
- Amount of grade change required or tolerated (curbs, crossslope, R/W, stream or cut encroachment, etc.)*
- Location and extent of widening
- Location and extent of alignment changes*
- Extent of current or future planned projects on the same section of highway
- Unusual traffic patterns on a project*
- Areas where soft subgrade may be encountered
- Age, condition and upgrade plans for utilities under the pavement*
- Type of drainage facilities in place or to be placed*
- Actual type of curb present*
- Change in traffic pattern use on existing pavement*
- Extent and frequency of chain usage
- Extent and frequency of snow plow damage
- Grade constraints at bridges
  * Important for urban area projects

10.6.4 URBAN PAVEMENT REHABILITATION PROJECTS (IN TOWN, CURBED SECTIONS)

This type of project requires a very detailed review of several of the items listed above before field work should be conducted for development of the pavement design. The items are designated with an asterisk above. Many of these sections have very little curb exposure left or have unacceptable cross-slopes and/or other geometric features. This type of information is very important in determining the options available and the type of fieldwork necessary to develop the design. For more information regarding field work and pavement design for urban projects refer to the ODOT Pavement Design Guide.
10.6.5 PAVEMENT PRESERVATION MINIMUM DESIGN LIFE

All pavement designs must meet the minimum design life requirements outlined in the ODOT Pavement Design Guide. A design exception may be requested through the process described in Chapter 14. Typical acceptable reasons for getting a design exception are as follows:

1. A life cycle cost analysis shows that the proposed maintenance/rehabilitation strategy is more cost effective than what would be required to meet the minimum design life.

2. The proposed short term fix keeps the road passable until a project can be put in the STIP to provide a long term solution. A commitment should be made at the time of the agreement of the exception to get the project into the next STIP.

10.6.6 PROJECT SCOPING AND DESIGN ESTIMATES

The Pavement Design Group is also available to assist in the prospectus development and project scoping process. In most cases the Pavement Design Group can develop a preliminary design estimate that will be fairly close to the requirements of the final design. By using the Pavement Design Groups' expertise in the early stages of a project, the risk of significant cost overruns due to changes in the pavement design may be minimized.

For projects with asphaltic concrete quantities in excess of 400 tons, the designer should include a separate bid item for the liquid asphalt. Any request to not have a separate bid items should obtain the approval of the pavement designer. In addition, the standard liquid asphalt quantity is equal to 5.7% of the mix for ¾ inch HMAC pavements and 6.2% of the mix for ½ inch HMAC pavements. Any deviation to the standard liquid asphalt quantity requires the approval of the pavement designer.
## 10.7 PERMITS & DOCUMENTS

### 10.7.1 PERMIT RESPONSIBILITIES

A number of permits and/or documents may be required from various agencies during the advance of a project from design to construction. The following list of permits and the units responsible for obtaining them is as comprehensive as possible at this time:

<table>
<thead>
<tr>
<th>Permit</th>
<th>Issuing Agency</th>
<th>Responsible Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport Clearance</td>
<td>Federal Aviation Administration (FAA)</td>
<td>Region Tech Center / Engineering Services / through Aviation Department</td>
</tr>
<tr>
<td>Railroad Crossing (New and Alteration)</td>
<td>ODOT</td>
<td>Rail Division</td>
</tr>
<tr>
<td>Section 401 of Clean Water Act (Water Quality Certification)</td>
<td>Department of Environmental Quality (DEQ)</td>
<td>Environmental Permits Coordinator</td>
</tr>
<tr>
<td>Land Use Plan (Conditional Use; Flood Department Plain, etc.)</td>
<td>County/City Planning Department</td>
<td>Region Office</td>
</tr>
<tr>
<td>Building Permit</td>
<td>County/City</td>
<td>Region (Project Mgr.)</td>
</tr>
<tr>
<td>Other Local Permits</td>
<td>Irrigation/Diking Districts, etc.</td>
<td>Region Office</td>
</tr>
<tr>
<td>Right of Entry/Use Permits (through USFS/BLM Lands)</td>
<td>U.S. Forest Service/Bureau of Land Management (BLM)</td>
<td>Region Office / R/W</td>
</tr>
<tr>
<td>Material Site</td>
<td>Oregon Department of Geology &amp; Mineral Industries (DOGAMI)</td>
<td>Region Geologist Resources*</td>
</tr>
</tbody>
</table>

* For Commercial and other Contractor Option sites, the permit is obtained by the Contractor, Site Operator, or Landowner.

| Coastal Zone Management                    | Oregon Dept. of Land Conservation & Development (DLCD)     | Environmental Permits Coordinator                       |
The Project Prospectus (Part 2 and Part 3) will, in most cases, identify those permits and documents required for each project, and who is responsible for obtaining them.

Permits for some local agency and off-system projects are to be obtained by the agency or the consulting engineer as stipulated in the Oregon Department of Transportation/Agency agreement for the project.

An Air Quality report is required for all projects that increase capacity in Portland, Salem, Eugene, Medford, Grants Pass, and Klamath Falls, La Grande, Oakridge, Lakeview.

FHWA also requires a Hazardous Materials report or other documentation.
10.7.2 PERMIT TYPES

10.7.2.1 AIRPORTS

In compliance with Federal Aviation Regulations (PART 77), "Objects Affecting Navigable Airspace," highway projects within 20,000 feet of an airport will be carefully examined by Project Support and/or Roadway Engineering prior to the public hearing stage to determine if there is a possibility of conflict.

When it is determined that a notice is required, the Engineering Services Unit will complete FAA Form 7460-1 and submit it to the Federal Aviation Administrator as prescribed in FAA Reg. 77.17 via the Oregon Department of Aviation at least two months before construction begins. If during the preliminary design phase an obstruction conflict becomes apparent, immediate contact with FAA should be made.

10.7.2.2 DIKING AND IRRIGATION DISTRICT

When a proposed highway project is expected to impact an existing development that involved Federal funds in its construction (such as dikes, irrigation projects, revetments, dams, etc.) an investigation shall be made by the Project Manager or a designated representative of the Region Manager, to determine the need for notification, approval or permits of another agency. In most cases, approval will be required from the Federal authority originally involved, as well as the local agency.

The Project Manager should establish communications with these Districts to alert them that some work is proposed that will affect their facility and to ascertain what special considerations are needed in the project plans & specifications.

10.7.2.3 USE PERMITS AND AGREEMENTS

Right of way over government land is acquired through right of entry on Bureau of Land Management property and through an easement from the U.S. Forest Service. Applications for these are made through the Right of Way Section in Salem. The government classification and proposed right of way lines are to be shown on the detail map in the usual manner. The Memorandum of Understanding between the U.S. Forest Service and the Oregon Department of Transportation details the process by which right of way through National Forest land is obtained. The issue of obtaining right of way over government land is a very detailed and time consuming process. There are other permits and authorizations required from the U.S. Forest Service, Bureau of Land Management, and other Federal Agencies.
10.7.2.4 DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

A permit is required from DOGAMI for all work in all aggregate sources or borrow sources, whether publicly owned, privately owned and commercially operated, or other private sources (e.g., a farmer). These permits control the development and assure the reclamation of the sites as required by state law (ORS 517.750 - 517.955).

After the need for borrow/aggregate has been determined, the Region Geologist will determine whether ODOT will offer its own prospective source or rely on the contractor to obtain his own material source.

When the source is ODOT owned or controlled (ODOT has a lease with the landowner), the Region Geologist will determine the source and prepare the necessary documentation for the permit. The application and supporting documentation and fee is then submitted directly to DOGAMI.

The Region Geologist will forward a copy of the development plan and reclamation specifications directly to the designer for incorporation into the plans and specifications.

When the contractor provides the source, the contractor will obtain the permit. The Construction Project Manager has the ultimate responsibility to verify that the material site has a valid DOGAMI permit.

10.7.2.5 U.S. COAST GUARD PERMIT

Some of the larger rivers as well as bays and estuaries in Oregon are considered to be navigable. The Coast Guard and the Corps of Engineers operate according to a list of officially designated navigable waters. Commercial navigation may no longer be practical in some of the waterways listed as being navigable and projects over those waters may be exempt from the need for a permit. Since it is easier to define when a permit is not needed that will be the starting point.

For projects involving the construction of bridges or the major reconstruction of bridges over navigable waters a Coast Guard permit may not be required if the bridge is over waters:

1. Which are not being used or are not susceptible to use in their natural condition or by reasonable improvement as a means to transport interstate or foreign commerce; and
2. Which are (a) not tidal, or (b) if tidal, used only by recreational boating, fishing, and other small vessels less than 21 feet in length. (Federal Aid Highway Manual, Vol. 6, Chapter 7, Sec. 1, Par. 1)

The Permit Coordinator requests that the Federal Highway Administration makes the determination that a Coast Guard permit is not required under these criteria.

If the waters in question do not meet Criteria 1 and 2 above, a Coast Guard Permit will be required.
The application for the permit is made by letter to the 13th Coast Guard District (Seattle). This application should be made one year in advance of the project construction date.

The Coast Guard should be contacted and their comments requested about provisions for navigation when a project involves a navigable waterway, whether or not a Coast Guard permit is required. Their stipulations concerning such items as navigation clearances, lighting, etc., will then be included in the project plans and specifications.

10.7.2.6 U.S. CORPS OF ENGINEERS/DIVISION OF STATE LANDS PERMIT

The US Army Corps of Engineers (USACE) regulates discharge of dredged or fill material into waters of the United States, including wetlands, pursuant to Section 404 of the Clean Water Act (33 S.C. 1344). A permit will generally be required when filling into waters of the U.S.

The Oregon Division of State Lands, as the state regulating agency, will generally require that a permit be obtained for fill or removal in the beds or banks of streams or wetlands. A joint permit application form is used for both of these agencies. However, two or more permits may be issued.

The joint permit application is reviewed by State and Federal Resource Agencies (ODFW, DEQ, USFWS, EPA, NMFS, etc.) for compliance with statutes, such as the Endangered Species Act (ESA), and good resource management practices. Their comments and conditions will be incorporated into the permits.

It is extremely helpful during the field survey for the Project Manager to contact the local District Fish Biologist of the Oregon Department of Fish & Wildlife to discuss the project and learn in advance the conditions under which work will be allowed in any streams. The Permits Coordinator obtains the permit. Application is made when the following information is available for the impact site:

1. Vicinity map which shows the location of the project.
2. Plan, elevation and typical section drawings which show the existing and proposed structures.
3. Any environmental documents required for the project such as a Wetland Delineation, Impact Assessment and Mitigation Report.
4. The Biological Assessment for the project impacts to the threatened and endangered species can be sent when it is completed.

This information should be submitted as early in the design process as possible. This will insure any conditions or stipulations contained in the permits can be incorporated into the project plans and specifications. These conditions may be as minor as time limits for in-stream work or as major as extensive wetland mitigation plans.
Any special conditions or stipulations regarding work in the stream are then included in the final project plans and specifications. (For Corps of Engineers Permit Rules see Code of Federal Regulations (CFR 33, Ch. 11, part 323)

10.7.2.7 CONSTRUCTION PERMIT

The construction permit applies to land service facilities to be built for individuals on their land. It gives the State or its contractor a right to enter upon the property of an individual to perform construction work for the benefit of the owner. This might include road approaches or access roads which cannot be accommodated in their entirety within the highway right of way; irrigation facilities which serve only the individual involved; or any other facility constructed for the sole use and benefit of the owner involved, the later removal of which would not be detrimental to the highway. No time limits are placed on construction permits.

10.7.2.8 STORMWATER REPORT

The stormwater report can be produced by Roadway or Geo/Hydro, and these two working groups may have shared responsibility for different sections of the calculations and documentation. The report should provide documentation of the design calculations supporting the final plans and specifications. See section 10.5.7 for specific information about the stormwater report.
10.8 RAIL

10.8.1 GENERAL

As with airports, rail crossings in the vicinity of projects cause the influence areas of the respective modes to overlap. Projects near railroads, light rail, and other rail system crossings need to be reviewed for potential impacts. Rail crossings may be at-grade or grade separated depending on elements such as type of facilities, conflict points, and safety requirements. It is desirable to avoid or reduce at-grade rail crossings. Discussions between the Project Team and Rail Division should be held to determine the need to grade separate the crossing or leave it as an at-grade crossing.

Roadway projects in the vicinity of railroads need to accommodate the type of cargo and goods that are exchanged between rail and other transportation modes such as truck freight. Turning radii, travel lanes, or additional dedicated turn lanes need to be considered in the accommodation of vehicles moving such cargo and goods between roadway freight and rail lines. The existing Transportation System Plans should be reviewed to determine any related rail transportation needs.

ODOT Rail Division’s jurisdiction for the regulation of the railroad-highway at grade crossings extends a distance equal to the stopping sight distance (SSD), for the posted or statutory speed, measured back from the location of the stop clearance line at the railroad crossing (OAR 741-100-0005).

Because ODOT Rail Division has jurisdiction within the SSD from the stop clearance line, it is important to include them in the scoping phase of project development so that there is enough time to obtain a Rail Crossing Order if needed. It is also important to include the State Railroad Liaison in the scoping as they will be developing an agreement with the Railroad Company. (See Right of Way Manual, Chapter 10)

Failure to coordinate with ODOT Rail Division and the State Railroad Liaison will result in excessive delays to your project schedule.

10.8.2 FIELD DIAGNOSTIC REVIEW

The field Diagnostic Review is part of the requirements found in 23 CFR Part 646 – Railroads, Part 646.214 – Design. This will occur early in the design process, at project scoping or prior to DAP plans, and is coordinated by the State Railroad Liaison and the Rail Division. The review typically includes the following members:

- The State Railroad Liaison
The field diagnostic review team will meet on-site to determine the required safety upgrades to the railroad crossing. The findings from the field diagnostic review will be the starting point for:

- Identifying design constraints and work to be completed;
- Completing the Railroad-Highway Public Safety Application (which is required to obtain the Rail Crossing Order for ODOT Rail Division; and
- Obtaining any necessary design exceptions.

### 10.8.3 RAIL CROSSING ORDERS

Each public railroad crossing is required to have a Rail Crossing Order. Rail Crossing Orders are issued by the Rail Division and authorize the alterations to crossings, both at-grade and grade separated crossing types. Private crossings are not regulated by the Rail Division and therefore do not require a Rail Crossing Order. The majority of projects involving railroad crossings will require an Order to alter the subject crossing. New at-grade crossings are rarely approved by Rail Division because state law directs ODOT to eliminate railroad crossings at-grade, wherever possible.

Rail Crossing Orders contain specific requirements related to the roadway geometry and roadway features. In order to obtain a Rail Crossing Order, a Railroad-Highway Public Crossing Safety Application must be completed and submitted to Rail Division early in the design phase. (add web link) This application is typically done by the project team leader or designer, with assistance from the State Railroad Liaison.

### 10.8.4 RAILROAD ROADWAY PLAN SHEET

Rail Division requires a separate, sealed railroad roadway plan sheet to be included with the Railroad-Highway Public Crossing Safety Application. This plan sheet will be completed early on in the project, DAP or preliminary plans, prior to completion of the other roadway plan sheets for the project. This is due to the design phase and the Rail Crossing Order process running concurrently, with the requirement that Rail Crossing Order is complete prior to bid letting.
This plan sheet should contain the roadway design features that will be shown in the final roadway contract plans, including:

- A plan view of the railroad crossing
- Vertical grade
- Length of roadway surface, gates and lights, gate arms type
- Location of guardrail, gates by station and offset
- Curb exposure

The final signed and stamped railroad roadway preemption plan sheet Mylar should be sent to the Traffic-Roadway Section, who will then submit an electronic copy to the ODOT Rail Division and the State Railroad Liaison and archive the Mylar with the project plans.

While the railroad preemption plan sheet is not part of the contract plan set, it is an important and required part of the Railroad-Highway Public Crossing Safety Application.

10.8.5 DESIGN ELEMENTS

If at all possible, the intersection angle between the roadway and railroad should be as close to 90 degrees as possible. Right angle crossings maximize the driver’s view of the rail crossing, location of tracks, and view of on-coming trains. A right angle crossing is also preferred for bicyclists and pedestrians. Besides the same visual problems of such a crossing, angled crossings coupled with flange openings create problems for the thin tires of a bicycle. The flange opening width should be kept to a minimum through the entire rail crossing section.

Sight distance is a critical consideration at railroad crossings. Sufficient sight distance must be available to the driver to recognize the crossing, see and perceive the crossing device and the trains themselves, and come to a stop condition if necessary.

Horizontal and vertical alignments are very important at rail crossings. The vertical profile between the roadway and the rail crossing should be as level and consistent as possible for smooth transition between surface types, sight distance and visibility of the crossing, and ability to react to the specific situation. Rail crossings along horizontal curves are not preferred as they impact the visibility of the crossing and cause the driver to focus on the curvature of the roadway instead looking for a train.

Some additional design elements involved with rail crossings include location of driveways, other accesses, and signals located at rail crossings. Vehicular storage queues in the vicinity of rail crossing intersections must be carefully reviewed and measures taken to prevent trapping of vehicles on the rail crossing. Sign locations need to be thought out in order to maintain proper clearance between the roadway and the railroad tracks.

The minimum horizontal and vertical railroad clearance to be provided on crossings shall conform to ODOT regulations shown in Figure 4-8. Additional clearance may be required and
should be determined individually for each crossing. Information regarding these clearances shall be obtained from the Railroad/Utility Engineer. The Rail Division should be contacted when rail crossings are involved in a project.

10.8.6 CROSSING TYPES

The crossing type (signals, signals and gates, stop sign) is generally determined on a case by case situation, but typically the crossing will have both crossing gates and signal lights. The designer needs to take into account the lead time needed for interaction with other divisions such as Rail when a crossing is involved. The Rail Division should be contacted to determine the appropriate crossing type and other rail requirements.

10.8.7 STOPPING Lanes AT RAILROAD CROSSINGS

Additional stopping lanes at railroad at-grade crossings were formerly added routinely. In some cases stopping lanes are not justified. Section 6.24.2 of the ODOT Traffic Manual outlines the procedure for determining the need for additional stopping lanes at railroad at-grade crossings. Additional design guidance for railroad grade crossings can be found on Oregon Standard Drawings RD400 series, for use when stopping lanes have been justified.

10.8.8 CURB EXPOSURE

Curb exposure at railroad crossings is very important. Standard curb (barrier) is to be used. The roadway curb exposure at railroad protective devices shall be a minimum 7 inches for new construction and 6 inches for existing installations and for maintenance after initial installation. In overlay situations, the construction of a new curb should not be ruled out. Each situation should be looked at individually to determine the correct solution.
10.9 ROADSIDE DEVELOPMENT

10.9.1 GENERAL

Roadside development is work occurring on a transportation facility right of way that doesn't fall into other categories such as illumination, utilities, or access control. The purpose of roadside development is to help integrate the transportation facility into the surrounding environment, which includes the larger transportation corridor. The purpose may be environmental, cultural, functional, or combination of these. The work may be mitigation (avoidance or minimizing impacts), compensation (replacing functions that are impacted), or enhancement (creating or improving something desirable in the landscape). Also included in this category of work is comment and advice for the modification of the work of other technical specialties that is related to the affect on the natural or cultural landscape of the transportation facility. Roadside development work is most often a part of road projects, but it can be the sole purpose of a contracted project.

Because roadside development usually deals with multiple overlapping large and small systems, it is not easy to precisely describe the term, just as there is no exact definition of the term “landscape.” The normal ODOT practice is to have specialists participate in scoping roadside development work on significant projects.

For the reasons cited above, specific roadside development requirements can have a variety of origins. One critical source is the environmental document whose legal purpose is to determine project impacts and state the actions intended to deal with those impacts. Other typical sources of requirements are various kinds of permits, agreements with county or city governments, the operating policies of various authorities such as the U.S. Forest Service, and ODOT’s mission concerning the environment or quality of life for residents and visitors to Oregon. Some needs of a project are discovered as the project evolves because they relate to project impacts that come to light or are finalized during later stages of development. Final roadbed slope lines are one example.

It is important to note that the roadside development work done for projects is almost always required, rather than optional. For questions about the sources of requirements that are not referred to in this section, contact the Roadside Development Program Coordinator in the Geo-Environmental Section in Technical Services. One primary source of actions on federal participation projects is the National Environmental Protection Act (NEPA). For Roadside Development on complex projects, it is often necessary to conduct an inventory and analysis of visual resources along the project, determine the level of impact and identify measures to ameliorate or mitigate those impacts.
10.9.2 PROJECT DEVELOPMENT PHASES

10.9.2.1 PLANNING

The ODOT Transportation Development Branch (TDB) usually looks at the “big picture” to develop initiatives like the Corridor Program, and develop policies which integrate local land use policies with statewide transportation systems. Many of these policies condition what actions are to be taken later on in projects and in these cases, TDB or Region planners as well as published documents of the TDB such as the Oregon Transportation Plan or Transportation Corridor Plans can be important resources.

Local government or transportation-related planning also must be considered for a comprehensive project. Some sources of information or requirements include local and regional Transportation System Plans (TSPs), local comprehensive plans, transit plans, and impacts to or from other planned projects in local capital improvement programs. Also included in the planning phase is consideration of other known major factors such as proximity to parks, funding options, access management, or other critical features.

10.9.2.2 PROGRAMMING AND SCOPING

Timely anticipation of the need for roadside development work will help establish a realistic design schedule and budget. Any project may have roadside development, but the rule of thumb is that the greater the disturbance to the natural or built landscape, the greater will be the need for work. Key flags are sensitive environments or populated urban areas where extensive work is being proposed. A brief review of the sources of work in the first section may help in scoping, but specific development of needs with the appropriate specialists may be required. In spite of best efforts, there will be times that the total work is not determined until late in the project design phase.

10.9.2.3 DESIGN

Field data collection that enables design work to begin is important to the success of roadside development. Data needs vary for the kind of work anticipated and ideally will be determined during project scoping. Data must be requested as the need becomes clear in the design process. Examples of data are a survey of existing trees, analysis of native plant communities, existing and proposed topography, soil types and depths where planting is proposed, existing wetlands or other water features, available potable water supply information, existing noxious weed populations, or similar data. Also falling into the category of field information are government regulations, policies, or initiatives external to ODOT. Examples of these could be master plans for local improvement districts, zoning or development requirements, scenic waterway or byway requirements, and other similar kinds of information that must be known in order for design to be completed. Primary resources to research this kind of information are the Region
Permit Specialist, Local Government Coordinator, or Region Environmental Coordinator. Often, agencies with jurisdiction will have to be surveyed for relevant requirements, and project needs are sometimes determined through such forums as meetings with neighborhood groups or other stakeholders.

Roadside development design in ODOT often focuses on the proposed contract document or design products as one way to scope the design process. The following is a list of the most familiar contract document and design products:

- Roadside development conceptual mapping
- Sketches or renderings to illustrate concepts.
- Planting, Irrigation, and Contour Grading Plans
- Various environmental mitigation plans - whether specifically identified by name, such as Wetland Mitigation, or not
- Site Development Plan
- Typical or unique project details
- Cost Estimate with Bid Items
- Specification Special Provisions
- Special advice for project construction
- Post-construction Maintenance Plan

### 10.9.2.4 CONSTRUCTION

Design work of any type must be “biddable and buildable,” and also anticipate potential construction problems. This is critical for roadside development work because it usually deals with living systems that are subject to natural elements such as weather, and business elements such as supply of plant materials in a timely fashion. A few considerations are waterway high and low periods, planting seasons versus contract periods, problems caused by erodible soils, restrictions on work such as in-stream periods, the ability to water new plants where no irrigation system exists, length of the plant establishment period, and many other such issues. Good communication between the various parties involved in the origination and design of the work is required for successful construction, especially because "adjustment" of all types of project elements as construction progresses is the rule, rather than the exception.

### 10.9.2.5 POST-CONSTRUCTION

A critical concept in roadside development is, that in meeting legal and other requirements, ODOT is responsible for establishing permanent functions. Some examples of functions include modifying topography or establishing vegetation for specific purposes such as habitat mitigation, water quality enhancement, creation of new wetlands, neighborhood screening,
soundwall mitigation, or existing planting replacement. If state or federal permits are involved then the permit often requires monitoring after completion. For example, regulatory agencies require ODOT to monitor wetlands for five years to correct problems. Some cities require the replanting of newer street trees that fail to thrive after the plant establishment period ends. Federal funding participation brings with it the need to protect the federal investment. In the post-construction period, roadside maintenance is the most critical element in maintaining the designed function. However, there are other activities that affect roadside functions such as utility work, permit activities like plant collection, or other causes of disturbance.

ODOT regions are responsible for post-construction activities, and the system works best if the maintenance needs of new work are understood as the project is being developed. Transportation facilities such as roads are designed and built according to established needs, and then appropriate maintenance is programmed to keep the facility safe and functioning. In the same way, the best practice in planning for roadside maintenance is a clear understanding of the functions to be maintained and then working to ensure the ongoing maintenance capability.

10.9.3 ROADSIDE DEVELOPMENT RESPONSIBILITIES

Roadside Development is currently housed within the Environmental Section in each Region, although not every Region has a Landscape Architect on staff. The role of the Region Landscape Architect is to develop projects and provide design and contract document development support to other environmental disciplines as needed. The Statewide Roadside Development Coordinator is based in Salem in the Geo-Environmental Section of Technical Services. The Statewide Coordinator is responsible for related program and policy development, and also provides project support to Regions as needed and requested. Several other units have major responsibilities including the Geo-Environmental Section, Project Design Teams, and Region Environmental Specialists, among others. Private consultant landscape architects and environmental specialists may also have important design roles on projects.

Project teams are now responsible for overseeing the development of projects. Ownership of roadside development work generally follows the same path as other kinds of work; the specialists are responsible for their work but the project team determines how the work is conducted and coordinated on a given project. Whenever there are roadside design contract documents, the individual responsible for the design needs to be identified on the plan sheet. The Professional of Record will typically be a Registered Landscape Architect, but other design professionals may also prepare and stamp roadside development plans, if they have particular expertise in the field.

Roadside development offers a focal point to assess the whole project site at any point in development, and assess, mitigate, and compensate for project impacts. Every design specialty can participate in how their project work affects the quality of the roadside as well as how roadside environments impact the quality of the project. One example of this is how traffic signing designers now routinely call for painting the backs of signs on certain highways to reduce their visual contrast in scenic areas.
Projects are transferred to maintenance after construction, so they assume the ongoing responsibility. Their participation in project design and construction is critical for long term success. Roadside maintenance is one of the legs to the "three-legged stool" of planning, design/construction, and maintenance. The ability to provide long-term care for constructed designs allows ODOT to be able to continue to practice partnership with regulatory agencies such as FHWA, the Army Corps of Engineers, and many others. The advantage of this regulatory partnering to ODOT's ability to conduct project development cannot be overstated.

10.9.4 ROADSIDE DEVELOPMENT TOOLS AND REFERENCES

Some references for roadside development projects have already been mentioned, such as the project environmental document, permits, agreements, relevant policies or regulations of various agencies and governments, and project documents such as the Prospectus and Narrative. Some useful internal references are the Roadside Development Manual, Right of Way Development and Control part of the Standard Specifications for Highway Construction; the Roadside Development section of the Contract Plans Development Guide; and the Integrated Vegetation Management Guidelines. External references include A Guide for Transportation Landscape and Environmental Design by the American Association of State Highway Transportation Officials (AASHTO) and the American Standard for Nursery Stock from the American Association of Nurserymen (AAN).

Another important tool is the terrain modeling capability of ODOT's 'Intergraph InRoads' software. The use of terrain modeling for contour grading design will become a standard on road projects as it applies to landscape, wetland, and riparian restoration or enhancement. This allows accurate cross sections to be developed for testing alternate design concepts and for use during project construction. Project terrain modeling works best when anticipated in project scoping and scheduling. Other tools in use and expected to see greater use are photo image editing and three-dimensional rendering of site designs using Microstation CADD.

10.9.5 SPECIFIC PROJECT CONSIDERATIONS

It should be noted that every project which disturbs ground will need at least a minimal roadside development consideration, such as temporary and permanent seeding for site stabilization.

Conservation and protection of existing resources should be considered wherever possible and practical. This includes retention of existing vegetation or other habitat features, and salvaging project topsoil, stockpiling, and re-using on finished slopes wherever practical.

As we meet the basic design and construction needs of roadways and structures, existing native plant communities must be saved and protected wherever practicable. They can never be re-created exactly as they were before disturbance and attempts to re-create native plantings still meet with mixed success. Additionally, existing vegetation provides significant site stabilization, reducing the requirement for erosion control in those areas.
Roadside development requirements need to be identified during the location survey to assure that enough right of way is available for compliance. Sufficient right of way should be included to provide smooth finish grade transitions between existing landforms and the facility. Flattening steep slopes, slope rounding at the top and bottom of cuts and fills, and parabolic ditch sections are methods for developing a more compatible transition.

Additional right of way may be appropriate where issues exist such as endangered species or habitat preservation, wildlife corridors required to be protected, water quality facility locations, or transportation corridor visual quality.

High visibility areas and urban roadside areas almost always require some degree of ongoing maintenance. Slopes 1:3 or steeper can not be maintained by normal roadside mowing, so reducing slopes to less than 1:3 can reduce future maintenance efforts where mowing is acceptable. Planted shrubs and trees are an alternative to mowing on steep slopes and they have many other kinds of benefits. Even these planted areas, however, are not maintenance free and will receive maintenance activities on an as-needed basis.

Interchanges, except in special circumstances, require roadside development. The degree of treatment is determined by the amount of landform change, urban/rural nature of the site, local interests and participation, local ordinances, and other such factors. A basic level of roadside development, such as permanent seeding for site stabilization, is expected for all projects which disturb the ground surface. Since interchange areas are highly visible to many travelers every day, they often receive a higher level of treatment than other areas.

Sound berm designs should allow sufficient area (10 – 12 feet) between the toe of berm and the Right of Way for maintenance access.

Soundwalls should be set back from the edge of curb a minimum of 1.5 times the height of the wall. This achieves a better visual balance between the vertical mass of the wall and the horizontal plane of the roadway. It also helps address clear zone issues. Soundwall ends should be stepped down or wrapped around corners where streets intersect the highway. Soundwalls are a large vertical element on the land and treatment of their surface is important, as is the issue of graffiti on walls. The Roadside Development specialist should be involved when considering treatments (color, texture) for soundwall designs.

Areas that require landscape screening, such as residential areas or undesirable views visible from the highway, need sufficient Right of Way for plantings while maintaining clear zone requirements and access to the areas.

Utility pole location signage placements and street tree plantings needs to be coordinated during design. This is often difficult because utility companies may not determine pole locations until very late in the design process.

Any area that is planted in any way must be able to be safely accessed for maintenance.

On federal participation projects, law requires that an amount equal to 1/4 of 1% (.0025) of the roadside development estimated cost must be used to plant native wildflowers. (Erosion control and some other costs are excluded.)
10.9.6 ROADSIDE DEVELOPMENT INITIAL PROJECT CHECKLIST

1. **ODOT Information** - Include or check roadside development items in project Prospectus, scoping, environmental documents, schedule, City-State Agreement, key contacts list, special needs such as riparian revegetation, state commitments, Scenic Byways or Scenic Rivers, and other critical policies or programs such as Transportation Corridors or Forest Highways.

2. **External Information** - Relevant city and county permit requirements, external review authorities, key contacts list, critical laws and policies of local, state or federal agencies, working partners, initial project objectives, water supplier, et cetera.

3. **Design and Construction** - Includes performing or coordinating roadside development scoping and preliminary budget, participation on project development team, research, preliminary concepts, designs, contract document preparation, plan sheet drafting, consultant oversight, expert plan review, construction observation, and consultation on change orders. A variety of professionals perform these functions.

4. **Roadside Maintenance** - Name of maintenance authority (ODOT or other), name of responsible contact, inclusion of maintenance in project development review, inspections, maintenance standards, maintenance agreement or contract, maintenance plan for designed areas, approximate resources needed, maintenance ability to meet needs added by project.
10.10 TEMPORARY AND PERMANENT EROSION AND SEDIMENT CONTROL

10.10.1 GENERAL

The ODOT Erosion Control Manual is the basis for design of Erosion and Sediment Control Plans (ESCP) and is used to assist the practitioner to prepare both temporary and permanent Erosion and Sediment Controls (ESC) on all ODOT projects. The Geo-Environmental section should be consulted about problems involving ESC design.

The purpose of erosion control measures is to minimize the disturbance of soil particles, to limit the transport of sediment-laden water from construction sites, and prevent discharge of sediment into receiving waters. The benefits include minimizing turbidity and its impact to water quality and fish habitat.

An erosion and sediment control plan (ESCP) is part of the data that must be prepared on all projects that disturb soil. It must be noted that the ESCP is a living/dynamic document and needs to be modified as and when changes are incorporated into the ESCP to comply with regulatory requirements. The ESCP contains best management practices (BMP) to minimize erosion and control sediment movement on the construction project. The BMP will have to be modified or upgraded (if necessary) to suit the site conditions from project inception to completion.

The Oregon Department of Environmental Quality, acting under Section 402 of the EPA’s Clean Water Act, requires that all construction activity disturbing 1 acre or more, of soil have an ESCP developed to comply with the National Pollutant Discharge Elimination System (NPDES) permit. Each region has an NPDES 1200-CA permit to cover work done within that region. Contact a Region Environmental Coordinator for a copy of the permit.

The Federal Highway Administration is required by Section 1057 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) to develop erosion and sediment control guidelines for states to follow when constructing highways using federal funds. In order to fulfill this requirement, on July 26, 1994 FHWA adopted the guidelines presented in Volume III of AASHTO Highway Drainage Guidelines.

As part of The Oregon Plan for Salmon and Watersheds, the Oregon Department of Transportation now assures erosion control plans are provided on all projects that disturb soil and use federal funding. Local jurisdictions may also have soil erosion and stormwater quality control requirements, and these should be considered on a location by location basis.

Temporary and permanent ESC measures need to be considered during the project planning. The topography and drainage patterns in the vicinity of the project site must be researched and
used during the development of ESCP. The ESCPs consist of drawings, details, and specifications that are included in the contract documents or in the designer’s narrative. The ESCP must contain all of the necessary elements to accomplish the goals and meet the limitations of permits. Contract documents include specifications in Sections 00280 and 170.30(c) to address contractors’ compliance with this permit.
10.11 TRAFFIC ENGINEERING

10.11.1 GENERAL

The design of a project will include traffic management elements such as the location and function of traffic control devices (signals, signing, pavement marking, etc). The Traffic-Roadway Section (TRS) provides traffic support during all phases of project development and construction. TRS provides standards for preparing project plans, specifications and estimates for traffic signals, ramp meters, variable message signs, permanent signing, and illumination. In addition, the Traffic-Roadway Section provides statewide policies and guidelines for all traffic control devices, administers ODOT’s Project Safety Management System and provides technical assistance for traffic operation improvements on state highways. TRS also manages traffic signal approvals, manages speed zone designations for all public roads, monitors traffic speeds, tests electrical equipment, and coordinates development of design standards. The designer should be aware of these traffic functions and the support which is available from TRS during the design phase of projects. The designer should provide adequate notification to TRS staff through the assigned traffic designer or designated representative to ensure timely input consistent with the project schedule. In addition to the traffic design aspects of projects, the designer should consider future maintenance access and right of way need for electronic traffic equipment.

For further discussion of the roles and responsibilities of TRS, as well as information regarding the use of traffic control devices, see the ODOT Traffic Manual. This manual contains information regarding policies, procedures, warrants, and design considerations for traffic related items.

10.11.2 AUTHORITIES OF THE STATE TRAFFIC-ROADWAY ENGINEER

The designer should be aware that State Traffic-Roadway Engineer approval is required for the installation or modification of traffic signals as well as other traffic control devices and applications. Other examples of applications requiring the approval of the State Traffic-Roadway Engineer include: provision of multiple turn lanes, emergency vehicle preemption capability, U-turns at signalized intersections, turn prohibitions, flashing beacons, marked crosswalks at uncontrolled intersections or mid-block locations, crosswalk closures, designation of one-way operation, speed zones, parking prohibitions, restriction of lane use by type of vehicle, variable message signs (and other ITS devices), and the approval of roundabout locations. (See the ODOT Traffic Manual for more detail.) Many of these authorities are designated by Oregon Administrative Rule or come through a letter of authority from the Technical Services Manager.
Typically all requests for approval of traffic control changes or applications come from Region Traffic. Region Traffic staff are familiar with the requirements for documentation and investigation of traffic control applications. The Region Traffic Manager or Engineer should concur with all requests before forwarding them to the State Traffic-Roadway Engineer.

Early participation of traffic representatives in project scoping and identification can identify items requiring approval of the State Traffic-Roadway Engineer as well as related traffic concerns with safety, operation, and application of traffic control devices.

10.11.3 SIGNALS

When a project involves signals the roadway designer should contact the Region Technical Center Signal Designer. Information that the signal design will require includes: roadway features such as elevation profiles; guardrail requirements; truck turning radius requirements; pedestrian ramp designs; utility locations (particularly poles, above ground wires and possible underground conflicts with infrastructure such as fiber optic lines); storm drain locations; lane use width; pedestrian ramp locations; proposed curb and corner radii alignments; or other features that will have a bearing on the placement of traffic signal equipment. It is very important that items such as signal cabinets, power service cabinets and signal poles be located where they are not obstructions to pedestrians, bicyclists, or vehicles. Overhead utility lines such as power and communications should be reviewed to determine any conflicts with signal poles and signal heads. Typically this field information is in electronic file format.

The signal designer will provide projected layout of signal equipment (poles and controller cabinet) and cost estimates. The signal designer will also provide technical expertise regarding the signal equipment such as signal pole foundation size, ramp metering, lane usage, and vehicle detection type and locations. In the case of retrofit projects, the signal designer can provide information on existing signal equipment locations, lane configuration, vehicle detection replacement, and signal phasing. Crosswalk locations are normally determined through communication between the roadway and signal designers.

One of the most essential items the signal designer can provide the roadway designer is locations where the purchase of right of way or easements is needed. This item is sometimes overlooked but is critical in keeping the right of way purchase process on track. It is essential that the roadway designer notify the signal designer in advance so that proper right of way needs are determined and submitted, enabling the purchase of all right of way needs to occur in one phase of the project.

In some projects, multiple signals are involved and are part of an interconnected traffic signal system. Safe and efficient traffic signal timing along state highways depends on optimal intersection spacing. It is difficult to predetermine where such locations should exist, although one-half mile intersection spacing for Statewide and Regional highways is often desirable. Items that are involved in interconnect systems include highway capacity, lane balance, cycle lengths, vehicle storage and progression speed. When a project involves multiple signals, the roadway designer should contact Traffic Operations to determine the need for a signal interconnect system.
Temporary signals may be needed for traffic staging or in temporary locations during project construction. As with permanent signals, the designer should contact and communicate with the Region Technical Center Signal Designer in the early project stages to ensure that adequate time is allowed for temporary signal design.

10.11.4 SIGNS

The designer should contact the Region Technical Center Sign Designer when a project involves signing. Typical information that the sign design will require includes a detailed sign inventory with dated photographs and accompanying highway milepost or station. Typically, a roadside inventory or detail map (electronic version) is provided that identifies sign locations. The sign designer should be provided with project limits and the scope of work. Projects that involve sign bridges or cantilevered signs will require communication between the sign designer, roadway designer and structure designer.

As with traffic signals, right of way or easement needs are critical for sign designs. Accurate right of way or easement acquisitions will lead to proper location of signs. The road designer should contact the Region Technical Center Sign Designer early on in project development to determine if signing will or should be included in the project. When notified early in the process the sign designer will be able to provide signing plans, special provisions, and right of way needs in an efficient manner.

10.11.5 SIGNAL AND SIGN SUPPORTS IN ISLANDS

Designers need to carefully weigh the benefits of constructing islands for the accommodation of sign and signal support. It may be preferred to look at other alternatives such as location of the supports on the other side of the roadway. If installation cannot be avoided and a raised island is considered necessary, consider the following priorities:

1. Clear islands with mountable curb are most desirable.
2. Where pedestrian or other small devices are necessary, they will be on breakaway supports.
3. Where a fixed object cannot be avoided, a brief, written justification should be attached to the preliminary plan review transmittal letter.

Standard barrier curb on islands will be considered inappropriate for use on any arterial or rural facility unless supported in the justification document noted in (3) above.

10.11.6 ILLUMINATION

Prior to illumination design for a project, it must first be determined if illumination is warranted for the project. Region Traffic identifies locations for illumination and forwards the
information to the Traffic-Roadway Section for determination of policy agreements and statewide consistency before proceeding with project illumination design. If there are agreements between ODOT and local governments, the designer or project leader should forward them to the illumination designer.

When it has been determined that illumination will be part of the project, the roadway designer will need to provide the illumination designer with final roadway alignment, detailed project information relating to illumination needs. Typically 30% roadway plans that include centerline profiles, cross sections, existing roadside features, roadway alignment, and right of way line information will be sufficient for the illumination designer. Communication between roadway designer, the illumination designer, bridge designer, and traffic signal designer is critical in providing proper illumination designs for a project.

10.11.7 STRIPING

Traffic-Roadway Section is responsible for the policies and guidelines regarding striping and pavement marking. The striping guidelines provide statewide consistency. The responsibility for completion of the striping plans on state highway designs rests with the Roadway Designer. Striping should conform to the Traffic Line Manual, Pavement Marking Design Guidelines, and the MUTCD.

10.11.8 INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

Intelligent transportation systems goal is to improve safety and reduce congestion on the roadway infrastructure through the use of technology. Some of the ITS applications include ice sensors (road and weather information systems); speed monitoring sites, variable message signs, traffic cameras, communication lines, and ramp meters. ITS projects can be stand-alone but it is important for the designer to consider ITS improvements as part of highway modernization/reconstruction project work.

As with other types of traffic projects, early identification of right of way needs is important. Items such as variable message signs, speed monitoring cabinets, and traffic cameras may require additional right of way or need to be protected by guardrail or barrier. Traffic cameras may require special right of way locations to allow proper orientation and field of view.

10.11.9 CRASH ANALYSIS

There are several tools available to the designer to assist with the crash analyses. The Motor Vehicle Traffic Crash Database, compiled and maintained by the Crash Data Unit, covers state, county, and city road systems. The SPIS (Safety Priority Index System) Reports and the Crash Summary Database is compiled and maintained by Traffic-Roadway Section. Other tools such
as the crash graphing tools help identify patterns of crashes and are available via the intranet, contact the region Traffic investigator for more information.

These reports and others allow the designer to summarize data by different characteristics, such as weather conditions, types of crashes and types of vehicles. Preparing collision diagrams to identify patterns is helpful. Familiarization with the volumes, speeds, physical features and geometry also assists in the process. Crash and fatality rates should be compared to the statewide average for similar facilities. After analyzing the specific site or segment the designer can better determine the appropriate actions for correction. Region Traffic personnel routinely perform crash analyses and can help with specific sites or trends and have the latest investigation on SPIS top 10% sites. Contact Region Traffic for assistance.

10.11.10 PROJECT SAFETY MANAGEMENT SYSTEM

Traffic-Roadway Section, in cooperation with other ODOT sections, has developed and is maintaining ODOT’s Project Safety Management System (PSMS). The PSMS consists of the Highway Safety Program and the Safety Priority Index System (SPIS). In addition the Traffic Section has developed plans around specific Safety Emphasis Areas (i.e., Roadway Departure and Intersections). See Traffic-Roadway Section’s Highway Safety Website for more information.

These elements consist of evaluation tools, plans and funding options. These tools will assist project leaders and designers to evaluate and improve safety on Oregon highways.

10.11.10.1 HIGHWAY SAFETY PROGRAM

The Traffic-Roadway Section administers the Highway Safety Program to encourage engineering improvements that address identified safety needs (i.e., SPIS locations). The funds are primarily federal funds from the Highway Safety Improvement Program (HSIP). The mission of the Safety Program at ODOT is to carry out safety improvement projects to achieve a significant reduction in traffic fatalities and serious injuries.

In addition the department receives 164 penalty funds from Transportation Safety Division Grants. These funds are allocated towards Safety Emphasis Areas (i.e., Roadway Departure)

For up to date information on the Highway Safety Program see the Traffic-Roadway Section Highway Safety web site. Also contact region traffic staff for more information.

10.11.10.2 SAFETY PRIORITY INDEX SYSTEM (SPIS)

SPIS is a methodology developed by ODOT to identify potential safety problems on state highways. Essentially, SPIS is a tool for comparing and prioritizing crash histories of state highway locations. Each year regional reports of the top ten percent ranked SPIS sites are
generated for review by Region Traffic. Region Traffic evaluates these sites for correctable safety problems and possible solutions. If a correctable problem is identified, a cost/benefit analysis may be performed. If viable options are identified, funding may be pursued.

10.11.10.3 SAFETY EMPHASIS AREAS

Data analysis of crash data is combined with cost effective strategies to identify locations for the most effective uses of funds in order to achieve a 20% reduction in targeted fatal and serious injuries. This approach involves deploying large numbers of low cost, cost effective countermeasures on targeted segments of roadways with a history of specific crashes.

10.11.11 WORK ZONE ANALYSIS AND CONSTRUCTABILITY

Work Zone Traffic Analysis is used to determine lane closure restrictions and delay estimates for highway construction projects. Lane closure restrictions are used to determine times when road work is less likely to adversely impact traffic. Lane closures restrictions are determined by comparing actual or forecasted traffic volumes to a Free Flow Threshold. Delay estimates are used to manage mobility throughout the highway system. An estimate of delay is the average additional travel time a construction project will add to a segment of highway.

The Region work zone traffic analysts determine both the lane closure restrictions and delay estimates for projects. The work zone traffic analyst should coordinate with the Region traffic control plan designer when developing the lane closure restrictions and delay estimates. The traffic analyst should send a formalized report recommending lane closure restrictions and delay estimates to the project leader and Region mobility liaison.

Several tools are available to determine lane closure restrictions and delay estimates. For segment analysis, the ODOT work zone traffic analysis methodology should be used. For work zones that are near convenient alternate routes or contain various types of traffic control (i.e. signals), the Highway Capacity Manual and recognized traffic simulation software should be used. For these more complicated analyses, the Transportation Planning Analysis Unit (TPAU) is available to help determine both lane closure restrictions and delay estimates.

The Traffic Control Plan can change based upon the lane closure restrictions and delay estimates. Determine both the lane closure restrictions and delay estimates early in the project development process and refine as the project progresses to PS&E. Document the lane closure restrictions and delay estimates and any supporting information in the project Transportation Management Plan (TMP).

10.12 TRANSPORTATION ANALYSIS

10.12.1 GENERAL

The Transportation Planning Analysis Unit (TPAU) and Region Traffic Sections, with assistance from region staff, cities, counties, and other state agencies, are responsible for providing highway design hour volumes, traffic analysis and performance measures such as volume/capacity ratios for projects and studies.

TPAU typically performs this work for large or complex systems and/or the Environmental Assessments (EA) and Environmental Impact Studies (EIS). Region Traffic staff typically does the analysis for operational, preservation, bridge and other small improvement projects as well as scoping and review of developer-submitted Traffic Impact Analysis (TIA). Criteria for TIA’s are discussed in the Development Review Guidelines available at http://www.oregon.gov/ODOT/TD/TP/pages/plans.aspx

ODOT traffic analysts scope and review consultant analysis work. The analyst should work iteratively with design staff in the development of alternatives. The ODOT Analysis Procedures Manual (APM) available at http://www.oregon.gov/ODOT/TD/TP/APM.shtml guides the analysis process from scoping through the analysis and documentation for projects and studies. Any traffic analysis performed involving state highways must conform to the APM or be explicitly agreed to by the Department.

10.12.2 PROJECTS

In project development, the traffic analyst should be involved beginning in the scoping phase and continuing throughout the entire process. The transportation analysis for modernization projects includes developing air, noise, and energy traffic data for environmental studies. The analyst may also furnish volumes and vehicles classifications for pavement design.

The analysis process is detailed in the APM for the analyst to furnish traffic information for base and (appropriate) future year(s), such as hourly and daily volumes along with truck percentages. The analysis should report performance information including lane configurations, volume/capacity ratio (v/c) and any other operational performance measures, 95th percentile queues/storage lengths, signal progression, and preliminary signal warrants. The analysis process and results must be documented in either technical memoranda or a narrative report.
10.12.3 DESIGN GUIDELINES

Table 10-2 shows the acceptable v/c ratios for project development/design. Table 10-2 applies to all modernization projects and should be applied within other project categories except for development review. A design exception should be processed if the volume/capacity ratios in Table 10-2 cannot be met. If it is known early in the planning or project development process, that the v/c measures cannot be met, the design exception should be sought at that time instead of later in the project design phase.

The volume/capacity ratios shown in Table 10-2 are generally different than those shown in the Oregon Highway Plan (OHP). The v/c ratio values in the OHP are used to assist in the planning phase identifying future system deficiencies. The OHP v/c ratio values also allow flexibility for land use applications and Transportation System Plans by having at-capacity v/c ratios in urban areas. The HDM v/c ratio values are different as the expectation is to provide a mobility solution that corrects those previously identified deficiencies and provides the best investment for the State in establishing 20 year design life solution. The Table 10-2 values, although v/c oriented, are based upon the AASHTO's "A Policy on Geometric Design of Highways and Streets - 2011".

Issues may arise when a large difference occurs between the design and planning v/c ratios particularly when alternative mobility standards have been adopted. The issues occur due to different interpretations of which measure applies. Technical Services should be contacted if agreement between Region Planning and Design staff cannot be reached on the use of the design-life requirement.

Although traffic data is needed in the design of all highway improvements, preservation type projects are primarily focused on extending the service life of the pavement while looking at cost-effective safety enhancements. Traffic forecasts can assist in making decisions regarding needed safety improvements as part of the 3R project (adding turn lanes, signals) or as a future stand alone project. Table 10-2 v/c ratios should be used as guidance in making cost effective safety improvement decisions for 3R preservation projects.

Region Traffic Unit and Region Roadway Design Unit need to determine when a design-life design exception request is required for a new or modified traffic signal. Consensus on the proposed improvements needs to be reached prior to submitting design exception requests for design life to Technical Services.

Design Life exceptions are not required on the following project types:

- Private approaches
- Unsignalized public approaches that do not modify their capacity
- Development review projects
- Operation STIP projects
- Maintenance projects not in the STIP
• Transportation System Plans

• Traffic Growth Management (TGM) projects that do not have design details and would not be considered a 4R project in the design phase, however, any future build scenario for TGM projects are to use the v/c ratios in Table 10-2.

Table 10-2: 20 Year Design-Mobility Standards (Volume/Capacity [V/C]) Ratio

<table>
<thead>
<tr>
<th>Highway Category</th>
<th>Inside Urban Growth Boundary</th>
<th>Outside Urban Growth Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Land Use Type/Speed Limits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-MPO outside of STAs where non-freeway speed limit &lt;45 mph</td>
<td>Non-MPO where non-freeway speed limit &gt;= 45 mph</td>
</tr>
<tr>
<td></td>
<td>STAs</td>
<td>MPO</td>
</tr>
<tr>
<td>Interstate Highways and Statewide (NHS) Expressways</td>
<td>N/A</td>
<td>0.75</td>
</tr>
<tr>
<td>Statewide (NHS) Freight Routes</td>
<td>0.85</td>
<td>0.75</td>
</tr>
<tr>
<td>Statewide (NHS) Non-Freight Routes and Regional or District Expressways</td>
<td>0.90</td>
<td>0.80</td>
</tr>
<tr>
<td>Regional Highways</td>
<td>0.95</td>
<td>0.85</td>
</tr>
<tr>
<td>District/Local Interest Roads</td>
<td>0.95</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Notes:

• Interstates and Expressways shall not be identified as Special Transportation Areas (STAs).

• The peak hour is the 30th highest annual hour. This approximates weekday peak hour traffic in larger urban areas.

• MPO category includes areas within the planning boundaries of the Bend, Corvallis, Eugene/Springfield, Medford, Portland (METRO) and Salem/Keizer Metropolitan Planning Organizations, and any other MPO areas that are designated after the completion of this manual.
10.12.3.1 ESTIMATING CAPACITY FOR HIGHWAYS

Since there are many variables that could affect the capacity of a highway, use the following process as a general guideline only. This process enables designers to estimate allowable daily traffic volumes. These volumes can be used to determine the correct number of lanes on a state highway has been identified in a prospectus. The allowable daily traffic volumes are not intended for detailed design purposes. The assigned traffic analyst will provide design level traffic data. If there is a discrepancy between the prospectus and the results from this analysis, a designer should contact the TPAU for a more detailed evaluation.

10.12.3.2 CAPACITY ESTIMATION PROCESS OUTLINE

1. Determine the “Highway Category” and “Land Use Type/Speed” for the facility that you are working with.
2. Determine the acceptable Volume/Capacity Ratio
3. Determine the average daily capacity
4. Determine the allowable average daily traffic volume (ADT)
5. Compare the allowable ADT to the 20-year future ADT projected for the facility.

Note: This estimation process uses two of the most critical adjustments when determining the capacity of a roadway (signals and truck traffic impacts). There are several other factors used by a traffic analyst when determining the actual capacity of a facility.

1. **Determine Highway Category and Land Use Area Type**: Refer to Appendix D of the Oregon Highway Plan.

2. **Determine Highway acceptable Volume/Capacity Ratio**: The maximum allowable volume/capacity ratios for state highways can be found in Table 10-1.

3. **Determine the Average Daily Capacity**: This process will allow you to estimate the average daily capacity for the highway under study/investigation. Note that this is only an estimation of the capacity, the Transportation Planning Analysis Unit should be contacted to determine the capacity of a roadway for design purposes.

\[
\text{Average Daily Capacity} = \text{Ideal Daily Capacity} \times \text{FS} \times \text{FT}
\]

- **Ideal Daily Capacity** – unadjusted capacity of a roadway (Table 10-3).
- **FS** – a factor to account for the presence of signals (Table 10-4).
- **FT** – a factor to account for the presence of truck traffic and the type of terrain (Table 10-5).
Table 10-3: Ideal Daily Capacity

<table>
<thead>
<tr>
<th>Highway Category</th>
<th></th>
<th>Land Use Type/Speed Limits</th>
<th>Land Use Type/Speed Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPO</td>
<td>Inside Urban Growth Boundary</td>
<td>Outside Urban Growth Boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-MPO outside of STAs where non-freeway speed limit &lt;45 mph</td>
<td>Non-MPO where non-freeway speed limit &gt;= 45 mph</td>
</tr>
<tr>
<td>Interstate/Expressways</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 lane*</td>
<td>74,500</td>
<td>NA</td>
<td>68,000</td>
</tr>
<tr>
<td>6 lane</td>
<td>117,500</td>
<td>NA</td>
<td>107,500</td>
</tr>
<tr>
<td>Statewide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Lane Undivided**</td>
<td>31,500</td>
<td>30,000</td>
<td>30,000</td>
</tr>
<tr>
<td>2 Lane Divided</td>
<td>39,000</td>
<td>37,500</td>
<td>37,500</td>
</tr>
<tr>
<td>4 Lane Undivided</td>
<td>51,000</td>
<td>48,000</td>
<td>48,000</td>
</tr>
<tr>
<td>4 Lane Divided</td>
<td>68,000</td>
<td>64,000</td>
<td>64,000</td>
</tr>
<tr>
<td>6 Lane Divided</td>
<td>102,000</td>
<td>96,000</td>
<td>96,000</td>
</tr>
<tr>
<td>Regional Highways</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Lane Undivided</td>
<td>30,500</td>
<td>29,500</td>
<td>29,500</td>
</tr>
<tr>
<td>2 Lane Divided</td>
<td>38,000</td>
<td>37,000</td>
<td>37,000</td>
</tr>
<tr>
<td>4 Lane Undivided</td>
<td>49,500</td>
<td>47,000</td>
<td>47,000</td>
</tr>
<tr>
<td>4 Lane Divided</td>
<td>66,000</td>
<td>63,000</td>
<td>63,000</td>
</tr>
<tr>
<td>6 Lane Divided</td>
<td>99,500</td>
<td>94,500</td>
<td>94,500</td>
</tr>
<tr>
<td>District/Local Interest Roads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Lane Undivided</td>
<td>28,000</td>
<td>28,500</td>
<td>28,500</td>
</tr>
<tr>
<td>2 Lane Divided</td>
<td>35,000</td>
<td>35,500</td>
<td>35,500</td>
</tr>
<tr>
<td>4 Lane Undivided</td>
<td>48,500</td>
<td>46,000</td>
<td>46,000</td>
</tr>
<tr>
<td>4 Lane Divided</td>
<td>64,500</td>
<td>61,500</td>
<td>61,500</td>
</tr>
<tr>
<td>6 Lane Divided</td>
<td>96,500</td>
<td>92,000</td>
<td>92,000</td>
</tr>
</tbody>
</table>

* The number of lanes refers to the total number of through lanes on the facility.

** For the purpose of this computation, a divided roadway has a raised median to prevent mid-block left turns or it allows mid-block left turning vehicles to exit from the through traffic lanes.
If the facility is in an urban area that has signalized intersections, the signalized intersection adjustment factor (FS) needs to be applied to the ideal capacity. FS is the same for all of the land use types/speed limits.

Table 10-4: Signalized Intersection Adjustment Factor (FS)  
(applied to ideal daily capacity if there are signalized intersections)

<table>
<thead>
<tr>
<th>Highway Category</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate</td>
<td>NA</td>
</tr>
<tr>
<td>Statewide</td>
<td>0.51</td>
</tr>
<tr>
<td>Regional</td>
<td>0.46</td>
</tr>
<tr>
<td>District</td>
<td>0.45</td>
</tr>
</tbody>
</table>

If the facility has truck traffic, the slower moving trucks will take up more capacity than a passenger vehicle, especially if they are traveling on grades. Table 10-4 shows the adjustment factors (FT) for truck traffic on Level (1-2%), Rolling (3-4%), and Mountainous (5% or greater) terrain that are one-quarter mile or longer.

Table 10-5: FT (Reduction factor for presence of trucks)

<table>
<thead>
<tr>
<th>Number of Lanes</th>
<th>Percent Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td></td>
<td>L*</td>
</tr>
<tr>
<td>2</td>
<td>.97</td>
</tr>
<tr>
<td>4-6</td>
<td>.95</td>
</tr>
</tbody>
</table>

* L - level terrain, which has a grade of 1-2%  
** R - rolling Terrain, which has a grade of 3-4%  
*** M – mountainous terrain, which has a grade of 5% or more

4. **Determine the Approximate Allowable Average Daily Traffic:** To determine the allowable average daily capacity for a facility, carry out the following computation:

\[
\text{Allowable Average Daily Traffic} = \text{Average Daily Capacity} \times (v/c \text{ from Table 10-2})
\]

5. **Compare the Approximate Allowable ADT to the 20-year future ADT projected for the facility:** If the forecasted ADT, found on the prospectus, is greater than the calculated allowable ADT, contact the Transportation Planning Analysis Unit for clarification.