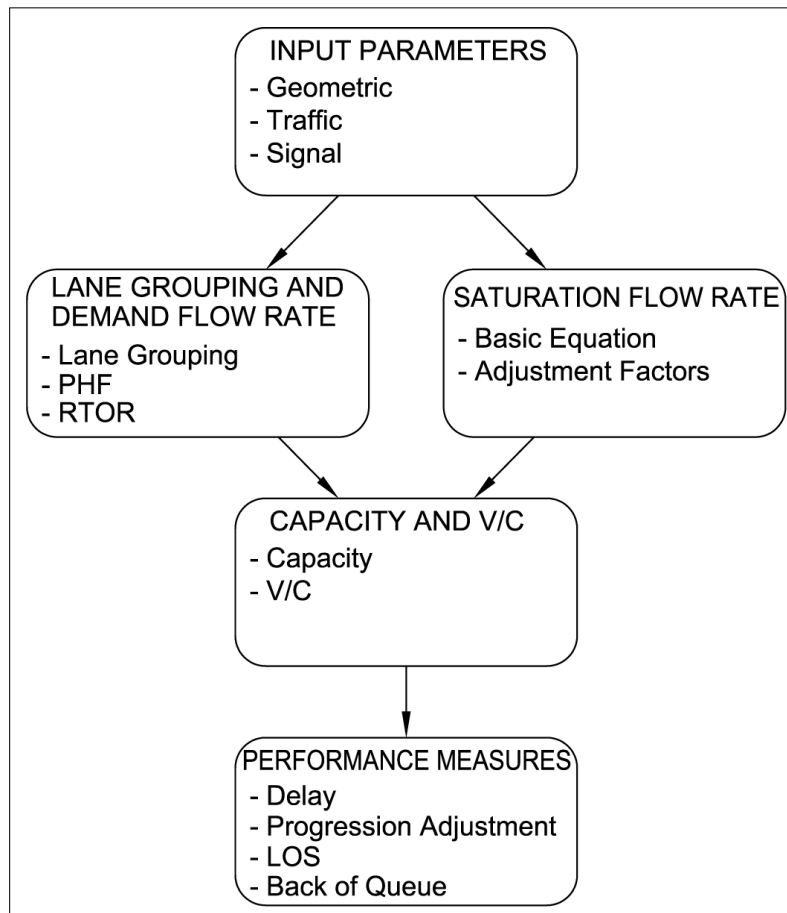


## **Technical Appendices**

- Appendix B      Significant Intersection Methodology
- Appendix C      Urban Street Segment Level of Service Methodology
- Appendix D      Existing Intersection LOS in 2002
- Appendix E      Summary of the Growth Management Act



### Signalized Intersection Methodology



The following shows LOS criteria for signalized intersections.

### LOS Criteria

The average control delay per vehicle is estimated for each lane group and aggregated for each approach and for the intersection as a whole. LOS is directly related to the control delay value. The criteria are listed below:

LOS CRITERIA FOR SIGNALIZED INTERSECTIONS	
LOS	Control Delay per Vehicle (s/veh)
A	<=10
B	> 10 - 20
C	> 20 - 35
D	> 35 - 55
E	> 55 - 80
F	> 80

The following figures show methodology used in determination of LOS and LOS criteria for non-signalized intersections, both all-way stop controlled and two-way stop controlled intersections.

## Part A. Two-Way Stop-Controlled Intersections

### I. INTRODUCTION - PART A

In this section a methodology for analyzing capacity and level of service of two-way stop-controlled (TWSC) intersections is presented.

### II. METHODOLOGY - PART A

Capacity analysis at TWSC intersections depends on a clear description and understanding of the interaction of drivers on the minor or stop-controlled approach with drivers on the major street. Both gap acceptance and empirical models have been developed to describe this interaction. Procedures described in this chapter rely on a gap acceptance model developed and refined in Germany. The concepts from this model are described in Chapter 10. Exhibit I illustrates input to and the basic computation order of the method described in this chapter.

### LEVEL-OF-SERVICE CRITERIA

Level of service (LOS) for a TWSC intersection is determined by the computed or measured control delay and is defined for each minor movement. LOS is not defined for the intersection as a whole. LOS criteria is given below:

<u>LEVEL-OF-SERVICE CRITERIA FOR TWSC INTERSECTIONS</u>	
<u>Level of Service</u>	<u>Average Control Delay (s/veh)</u>
A	0 - 10
B	> 10 - 15
C	> 15 - 25
D	> 25 - 35
E	> 35 - 50
F	> 50

## Part B. All-Way Stop-Controlled Intersections

### I. INTRODUCTION - PART B

This section presents procedures for analyzing all-way stop-controlled (AWSC) intersections.

### II. METHODOLOGY - PART B

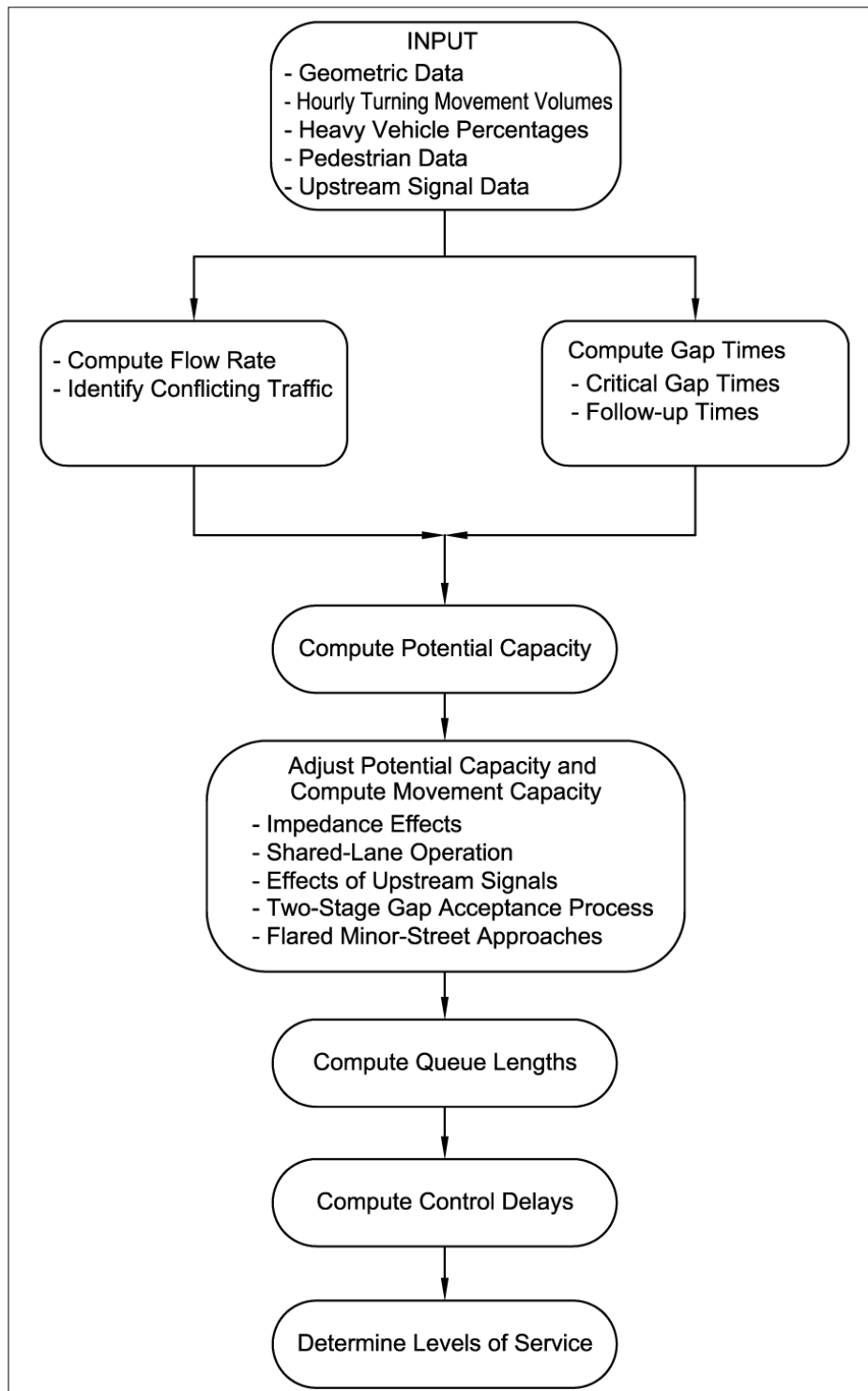
#### LEVEL-OF-SERVICE CRITERIA

The level-of-service criteria are given below. The criteria for AWSC intersections have different threshold values than do those for signalized intersections primarily because drivers expect different levels of performance from distinct types of transportation facilities. The expectation is that a signalized intersection is designed to carry higher traffic volumes than an AWSC intersection. Thus a higher level of control delay acceptable at a signalized intersection for the same LOS.

#### LEVEL-OF-SERVICE CRITERIA FOR AWSC INTERSECTIONS

Level of Service	Control Delay (s/veh)
A	0 - 10
B	> 10 - 15
C	> 15 - 25
D	> 25 - 35
E	> 35 - 50
F	> 50

**Exhibit I: Two-Way Stop-Controlled (TWSC) Unsignalized Intersection Methodology**



## Urban Street Segment Level of Service (LOS) Methodology

Urban street segment LOS is based on the average through-vehicle travel speed. The average speed is calculated from the travel time on the street segment and the control delay of the through movements at any signalized intersections. The control delay at the signalized intersections includes the delays of deceleration, stops, and re-acceleration.

The urban street LOS is calculated in four steps:

1. Determine the street class by field measurement or assessing the streets design category.
2. Determine the time required to drive the street segment.
3. Calculate the delays imposed on through traffic by any traffic signals in the street segment.
4. Calculate average travel speed.

Steps 3 through 4 can be calculated by using formulas provided in the *2000 Highway Capacity Manual, Transportation Research Board (Chapter 15)* or by using traffic modeling software such as Synchro/SimTraffic. Once the average travel speed is calculated the urban street LOS is read from the table below.

### Urban Street LOS by Class

Urban Street Class	I	II	III	IV
Range of free-flow speeds (FFS)	55-45 mi/h	45-35 mi/h	35-30 mi/h	35-25 mi/h
Typical FFS	50 mi/h	40 mi/h	35 mi/h	30 mi/h
LOS	Average Travel Speed (mi/h)			
A	> 42	> 35	> 30	> 25
B	> 34-42	> 28-35	> 24-30	> 19-25
C	> 27-34	> 22-28	> 18-24	> 13-19
D	> 21-27	> 17-22	> 14-18	> 9-13
E	> 16-21	> 13-17	> 10-14	> 7-9
F	≥ 16	≥ 13	≥ 10	≥ 7

Source: 2000 Highway Capacity Manual, Transportation Research Board



## ARTERIAL LEVEL OF SERVICE

Arterial level of service is defined in terms of *average travel speed* of all through vehicles on the arterial. It is strongly influenced by the number of signals per mile and the average intersection control delay. On a given facility, such factors as inappropriate signal timing, poor progression, and increasing traffic flow can substantially degrade arterial level of service. Arterials with medium to high signal densities (more than two signalized intersections per mile) are even more susceptible to these factors, and poor arterial level of service will probably be observed even before substantial intersection problems occur.

The following general statements may be made regarding arterial level of service:

1. **LOS A** describes primarily free-flow operations at average travel speeds, usually about 90 percent of the free-flow speed for the arterial classification. Vehicles are seldom impeded in their ability to maneuver in the traffic stream. Delay at signalized intersections is minimal.
2. **LOS B** represents reasonably unimpeded operations at average travel speeds, usually about 70 percent of the free-flow speed for the arterial classification. The ability to maneuver in the traffic stream is only slightly restricted and delays are not bothersome.
3. **LOS C** represents stable operations; however, ability to maneuver and change lanes in midblock locations may be more restricted than in LOS B, and longer queues, adverse signal coordination, or both may contribute to lower average travel speeds of about 50 percent of the average free-flow speed for the arterial classification.
4. **LOS D** borders on a range in which small increases in flow may cause substantial increases in approach delay and hence decreases in arterial speed. LOS D may be due to adverse signal progression, inappropriate signal timing, high volumes, or some combination of these. Average travel speeds are about 40 percent of free-flow speed.
5. **LOS E** is characterized by significant delays and average travel speeds of one-third the free-flow speed or less. Such operations are caused by some combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections, and inappropriate signal timing.
6. **LOS F** characterizes arterial flow at extremely low speeds, from less than one-third to one-quarter of the free flow speed. Intersection congestion is likely at critical signalized locations, with long delays and extensive queuing.

Arterial Levels of Service and Classification		
Level of Service	Average Travel Speed	
A	$\geq 30$	$\geq 25$
B	$\geq 24$	$\geq 19$
C	$\geq 18$	$\geq 13$
D	$\geq 14$	$\geq 9$
E	$\geq 10$	$\geq 7$
F	$< 10$	$< 7$
Range of free-flow speeds	30 to 35	25 to 35
Typical free-flow speeds	33	30

\*Further methodology used for arterial LOS calculations can be found in Chapter 11 of the HCM 2002.



## The Washington State Growth Management Act An Overview

Washington state's population is growing by more than a half a million people every decade. This rapid population growth is changing the way we live and work in many parts of the state.



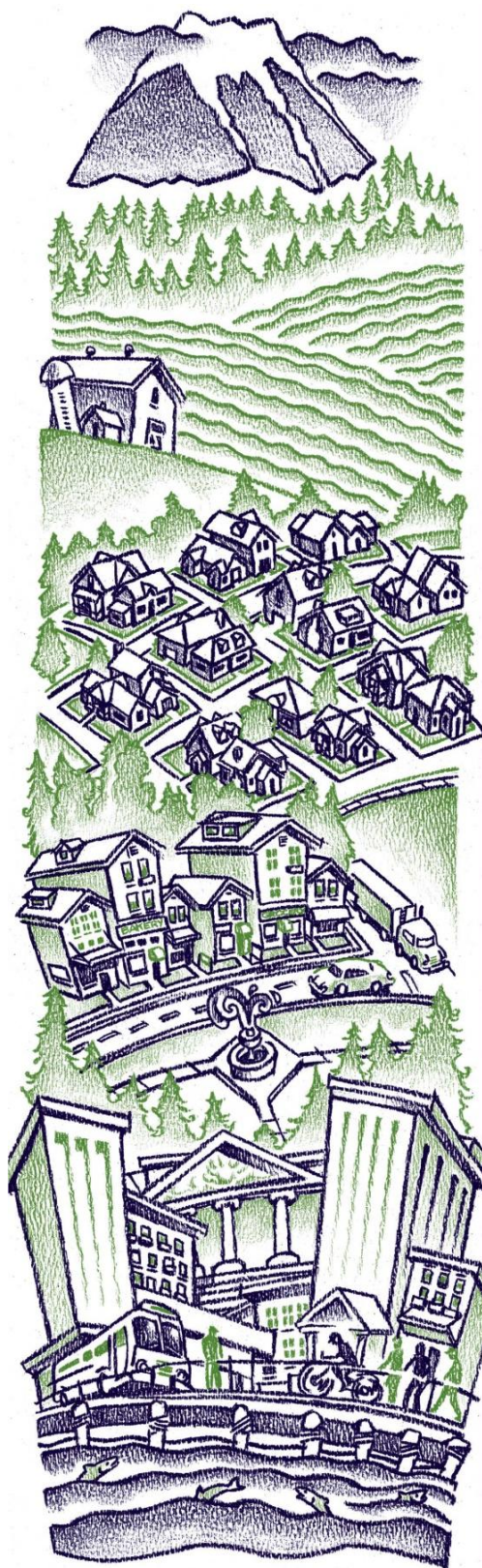
In response to this rapid growth, the Growth Management Act (GMA) was passed in 1990. Citizens

and lawmakers were concerned because population growth and suburban sprawl were threatening Washington's forest and agricultural lands, wetlands, and wildlife habitat. Traffic congestion, especially in Western Washington, was clogging the highways and polluting the air. Sources for clean drinking water were being threatened by increasing pollution. Flooding and landslides were becoming yearly events in areas of new development. Schools, sewers, and water supplies were being strained to keep up with growth.

In short, the quality of life that made Washington such a desirable place to call home was rapidly disappearing.

To address these problems, the GMA requires all cities and counties in the state to do some planning. It calls for the fastest growing counties, and the cities within them, to plan extensively in keeping with state goals on:

- sprawl reduction
- concentrated urban growth
- affordable housing
- economic development
- open space and recreation
- regional transportation
- environmental protection
- property rights



THE WASHINGTON STATE GROWTH MANAGEMENT ACT : AN OVERVIEW

- natural resource industries
- historic lands and buildings
- timely permitting
- public facilities and services
- early and continuous public participation
- shoreline management.

The GMA guides and encourages local governments with a full set of planning requirements in establishing their goals, evaluating their community assets, writing comprehensive plans, and carrying out those plans through regulations and innovative techniques to achieve their future vision. The state role under the GMA is to assist local governments in these efforts.

Since the GMA was passed, local communities have been working to meet its requirements. As a result many communities have made changes in how they are developing. For example, cities and counties are working together to determine where urban growth should go. Many communities are revitalizing their downtowns with attractive, compact urban development. Communities are planning for economic development to draw new businesses to their areas, while protecting the environment. Open space and recreational opportunities are being enhanced. Transportation policies are being examined and better ways are being sought to handle congestion and foster alternatives to the single-occupancy vehicle. Farm and forest lands have been designated and are being kept in production. Historic buildings are being preserved. Local communities are deciding how to provide more efficiently for public services, such as water and sewers, for growing populations. In more communities, environmental review is being combined with planning efforts. Most importantly, citizens are participating in planning for the future of their communities.

### **SOME COUNTIES AND CITIES ARE REQUIRED TO FULLY PLAN UNDER THE GMA; OTHERS CHOOSE TO MEET THE ACT'S REQUIREMENTS**

Any county (including cities within the county) is required to plan fully under the GMA if it has the following:

1. Both a population of 50,000 or more and a population increase of 10 percent or more over the last ten years. (Chelan, Clallam, Clark, Island, King, Kitsap, Pierce, Skagit. Snohomish, Thurston, Whatcom, and Yakima were the first counties required to plan under the GMA in 1990. Lewis, Grant and Spokane counties met this population requirement to plan later. In 1995 the percentage of population increase was changed to 17 percent.); or,
2. A population increase of over 20 percent for the last ten years regardless of current population. However, the legislative authority of a county with a population of less than 50,000 may adopt a resolution removing the county and the cities located in it from the requirement to prepare plans and development regulations. A resolution needs to be adopted within 60 days of the Office of Financial Management's (OFM) certification that the county meets the population requirement. (Jefferson, Mason, and San Juan counties met this population requirement after the GMA was passed and did not decline the requirement to plan under the act.)

In the remaining counties, a majority vote of the county commissioners to plan under the GMA triggers the requirement that the county, as well as all the cities within that county, plan

according to the act. (Counties that chose to plan are Benton, Columbia, Douglas, Franklin, Ferry, Garfield, Kittitas, Pacific, Pend Oreille, Stevens, and Walla Walla. Some of these, particularly those in Eastern Washington and rural parts of the state, saw GMA planning as a step to obtain needed services or to attract economic development.)

Twenty-nine counties are currently fully planning under the GMA. Together these counties make up about 95 percent of the state's population.



### **GMA RESPONSIBILITIES ARE REQUIRED FOR ALL OF WASHINGTON'S COMMUNITIES**

The GMA has a limited set of requirements for counties, and cities within their boundaries, that do not meet the population requirements and choose not to plan fully under the act. The requirements are:

- Resource lands (forest, agricultural, and mineral lands) and critical areas (wetlands, geologically hazardous areas, fish and wildlife habitat conservation areas, aquifer recharge areas, and frequently flooded areas) need to be classified and designated. Designated critical areas need to be protected.
- Every seven years local governments are to review their work on resource lands and critical areas to make sure it complies with the GMA, including the requirement to include the best available science when designating and protecting critical areas. Each county and the cities within it have a specific deadline for the review.
- All cities and counties with comprehensive plans are required to make their development regulations (zoning, subdivision, and other controls) consistent with their comprehensive plans.

The GMA requires the following of all counties and cities in Washington:

- Short plats and subdivisions may be approved only if written findings are made that adequate services are available, or that appropriate provisions are made for the public health, safety, and welfare.
- Any building permit application needs to supply evidence of adequate water supply for the intended use.

### **KEY GROWTH MANAGEMENT REQUIREMENTS FOR FULLY PLANNING CITIES AND COUNTIES ARE OUTLINED IN THE GMA**

The following requirements apply to local governments with a full set of planning requirements under the GMA:

- Counties, in conjunction with cities and towns, are required to develop county-wide planning policies. These policies provide a regional framework for counties and cities to allocate population projections, designate urban growth areas (UGAs) promote the orderly provision of urban services, assure affordable housing, and encourage economic development. The GMA requires multicounty planning policies be completed for Snohomish, King, and Pierce counties. Other counties fully planning under the GMA may complete them.

- Each county and the cities within that county work together to allocate the county's projected population. OFM provides each county with a 20-year population projection. OFM is required to review these population projections with counties and cities prior to their adoption. Counties are provided with high, medium, and low projections. The middle range is to represent OFM's estimate of the most likely population projection for the county.
- Counties, in consultation with their cities, are required to designate UGAs within which urban growth is to be encouraged and outside of which growth should occur only if it is not urban. These UGAs will, at a minimum, include all cities as well as the unincorporated areas needed to accommodate the 20-year projected population allocation for urban growth. New fully contained communities, master-planned resorts, and major industrial developments are urban developments allowed outside of UGAs, if certain criteria are met. UGAs are to be reevaluated every ten years based on new OFM population projections, developed from the most current U.S. Census figures.
- Resource lands are to be designated and policies developed to conserve them.
- Critical areas are to be designated and protected using the best available science
- Comprehensive plans provide the framework and policy direction for land use decisions. They are required to contain the following elements: land use, transportation, housing, capital facilities, utilities, shorelines, and rural (for counties). Elements addressing economic development and parks and recreation also are required, if state funding is provided. Optional elements may be included such as: conservation, energy, recreation, and subarea plans where appropriate. Comprehensive plan elements are to be consistent with each other. A local government's plan needs to be consistent with the county-wide planning policies and the plans of neighboring jurisdictions.
- Development regulations (zoning, subdivision, and other controls) are required to be consistent with comprehensive plans.
- Local governments need to determine what kinds of facilities and services they are going to provide to support growth. They also need to decide how they will finance facilities and services and show how they will provide them within a certain period of time.
- Once urban growth boundaries are established, no city annexations can take place outside the boundaries.
- Comprehensive plans are required to include a process for siting essential public facilities. No county or city can preclude these facilities. Transportation facilities of statewide significance and secure community transition facilities need to be included in policies for siting essential public facilities. The county and the cities in the county are to work with neighboring jurisdictions to jointly identify lands useful for public purposes (for example, landfills, sewage treatment facilities, and schools).
- Every seven years, each city and county with a full set of GMA planning requirements needs to review, and if needed, revise its comprehensive plan and development regulations to ensure they comply with the GMA. Some counties and the cities within them may have an extra year to complete a review of critical areas protections. The deadline to complete the first review varies according to a specific deadline established for each county and its cities. The earliest deadline is December 1, 2004.

## **STATE AGENCIES ASSIST LOCAL GOVERNMENTS IN GROWTH MANAGEMENT WORK**

The state's main GMA role is to assist and enable local governments to design their own programs to fit local needs and opportunities. This approach to meeting state goals is consistent

with Washington's long-held tradition of local governance.

The Washington State Department of Community, Trade and Economic Development (CTED) administers the GMA and coordinates the efforts of state agencies in carrying out the state's requirements under the act. State agencies provide information and assistance to help cities and counties develop their local comprehensive plans and development regulations. They also review draft plans and regulations.



Under the GMA, state agencies are required to comply with adopted county-wide planning policies, comprehensive plans, and development regulations of cities and counties.

### **THREE GROWTH MANAGEMENT HEARINGS BOARDS HEAR PETITIONS ON GMA COMPLIANCE**

Three regional growth management hearings boards hear petitions on whether state agencies, counties, and cities comply with the goals and requirements of the GMA and petitions on whether OFM's population projections should be adjusted. Boards for Eastern Washington, Central Puget Sound (Snohomish, King, Pierce, and Kitsap counties), and Western Washington hear petitions from their areas. Each board has three members appointed by the Governor.

The state, counties, cities, and aggrieved persons (who take part in the local government's planning process or are certified by the Governor) can petition the boards. There are additional limitations on petitions by the state.

Comprehensive plans and development regulations are presumed valid upon adoption. (An exception is the Shorelines Element, which requires the approval of the state Department of Ecology.) A growth management hearings board can decide otherwise only if a petitioner shows that a county or city erroneously interpreted or applied the GMA.

### **THE GOVERNOR CAN USE INCENTIVES AND SANCTIONS**

Sanctions can be imposed if a growth management hearings board makes a finding that a county, city, or state agency has failed to comply with a board order and submits a recommendation to impose sanctions to the Governor. The Governor may, without prior hearings board review, impose sanctions for failure to meet a GMA deadline.

Incentives, penalties, and sanctions for counties and cities out of compliance with the GMA can be applied through state grants, loans, and taxing authority. Sanctions for state agencies can be withholding of state agencies' allotments.

### **GMA OFFERS A FRAMEWORK FOR IMPROVING PERMIT SYSTEMS**

The GMA is the basis for a law passed in 1995 to improve how permits for projects are issued in Washington. The regulatory reform law seeks to make three planning laws - the Growth Management Act, State Environmental Policy Act, and Shoreline Management Act - work together more smoothly. It requires all local governments to combine environmental review and permit review. The number of hearings and appeals also are limited for all local governments.



## GMA PROVIDES ESSENTIAL TOOLS FOR MANAGING GROWTH

- CTED has developed and adopted rules under the Washington Administrative Code to help local governments carry out the GMA. The minimum guidelines assist counties and cities in designating resource lands and critical areas. The procedural criteria assist counties and cities in adopting comprehensive plans and development regulations. An amendment to the procedural criteria gives guidance on how local governments can use the best available science to designate and protect critical areas. The project consistency rule provides guidance on how to analyze project proposals for consistency with GMA plans and regulations.
- Impact fees are authorized for public streets and roads, public parks, open space and recreation facilities, school facilities, and fire facilities that are not part of a fire district. This financing system for off-site improvements is to provide for a balance between impact fees and other sources of public funds. Impact fees alone cannot be used to fund systems improvements. Only cities and counties required or choosing to plan under the GMA can impose impact fees.
- An additional 0.25 per cent real estate excise tax is authorized (without voter approval) for cities and counties required to plan. Those choosing to plan under the GMA may by such a tax after voter approval. Revenues from this tax are to be used solely as a public contribution to the development of capital facilities, such as roads and sewers, that are identified in the capital facilities plan.
- Six counties and the cities within them are to determine, under the Buildable Lands Program, if an adequate amount of land is being provided for future urban growth. They collect data to evaluate their growth management plans, including whether they are achieving urban densities within adopted urban growth boundaries. The counties are Clark, King, Kitsap, Pierce, Snohomish, and Thurston.



## HELP IS AVAILABLE TO CARRY OUT THE GMA

Regional transportation planning organizations (RTPOs) are authorized as voluntary associations of local governments within a county or within contiguous counties to conduct regional transportation planning. RTPO grants are available through the Washington State Department of Transportation to do regional transportation planning. RTPOs review the transportation elements of local comprehensive plans and county-wide planning policies and certify they are consistent with regional transportation plans.

Technical assistance for carrying out the GMA is available to cities and counties from Growth Management Services. For more information or copies of publications on GMA planning, call 360.725.3000 or write Growth Management Services, 906 Columbia Street SW, P.O. Box 42525, Olympia, WA 98504-2525. You can also see Growth Management Services' website at [www.ctedwagov/growth](http://www.ctedwagov/growth).