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# Metro's Regional Land Information System: The Virtual Key to Portland's Growth Management Success

Gerrit Knapp

*University of Maryland, College Park*

Richard Bolen

*Metro Portland*

Ethan Seltzer

*Portland State University, dkes@pdx.edu*

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**Metro's Regional Land Information System:  
The Virtual Key to Portland's  
Growth Management Success**

Gerrit Knaap, Richard Bolen,  
and Ethan Seltzer

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Working Paper**

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## **Metro's Regional Land Information System: The Virtual Key to Portland's Growth Management Success**

### **Abstract**

Though metropolitan Portland, Oregon, has perhaps the best-known growth management program in the world, one of the most important elements of that system has been conspicuously overlooked: the regional land information system (RLIS). Since RLIS was developed in the late 1980s, it has played a critical role in the development of every significant plan, the evaluation of every key policy, and the formulation of every major development model. RLIS created conditions that enabled a sophisticated and now much-studied approach to metropolitan growth management to emerge. In this paper, we discuss the development, use, and maintenance of RLIS, illustrating its importance for both the practice of regional planning and the advancement of planning research. We begin with an overview of planning at Metro, since it is that context that provides RLIS with much of its local and political meaning. We then examine the relationship of RLIS to specific Metro planning activities. We conclude that RLIS in particular, and regional GIS systems in general, have become vital to the success of urban growth management.

## About the Authors

**Gerrit-Jan Knaap** is Professor of Urban Studies and Planning and Director of the National Center for Smart Growth Research and Education at the University of Maryland. Knaap's research interests include the economics and politics of land use planning, the efficacy of economic development instruments, and the impacts of environmental policy.

Contact information:

National Center for Smart Growth Research and Education  
Urban Studies and Planning Program  
University of Maryland  
1112M Preinkert Field House #054  
College Park, MD 20742  
Phone: (301) 405-6083  
E-mail: [gknaap@ursp.umd.edu](mailto:gknaap@ursp.umd.edu)

**Richard Bolen** is the Urban Research Program Director for Metro, the Portland Metropolitan area's regional government. His 14-member multi-disciplinary group conducts urban research and forecasting, relying on its GIS based Regional Land Information System (RLIS) and land development forecasting model, MetroScope. Richard has extensive urban planning experience, which facilitated the design and development of Metro's policy support system.

Contact information:

Metro, Data Resource Center  
600 NE Grand Avenue  
Portland, OR 97232  
Phone: (503) 797-1582  
E-mail: [bolend@metro.dst.or.us](mailto:bolend@metro.dst.or.us)

**Ethan Seltzer** is a Professor in and the Director of the School of Urban Studies and Planning at Portland State University. Prior to that, he served as the founding Director of Portland State's Institute of Portland Metropolitan Studies and as the Land Use Supervisor for Metro, the regional government in the Portland region. Currently, he also serves as President of the City of Portland Planning Commission.

Contact information:

School of Urban Studies and Planning  
Portland State University  
P.O. Box 751  
Portland, OR 97207  
Phone: (503) 725-4045  
Fax: (503) 725-8770  
E-mail: [seltzere@pdx.edu](mailto:seltzere@pdx.edu)  
Web: [www.upa.pdx.edu/USP](http://www.upa.pdx.edu/USP)

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## **Metro's Regional Land Information System: The Virtual Key to Portland's Growth Management Success**

### **Introduction**

Metropolitan Portland, Oregon, has perhaps the best-known growth management program in the world. Policy makers from Europe, Asia, Latin America and, of course, North America annually trek to Portland to learn about its regional form of government, its urban growth boundary, and its light rail transit system. Meanwhile, scholars and journalists of all persuasions fill books, journals, and newspapers with criticism and praise for Portland's style of growth management.

Though the debate has raged for nearly three decades, one of the most important elements of metropolitan Portland's growth management system has been conspicuously overlooked: that is, Portland's development and use of an advanced regional land information system (RLIS). Since RLIS was developed in the late 1980s, it has played a critical role in the development of every significant plan, the evaluation of every key policy, and the formulation of every major development model. Though the relative success of each of those plans, policies, and models has been widely discussed, the critical role of RLIS has gone largely unnoticed.<sup>1</sup>

The development of the Regional Land Information System at Metro, Portland's regional government, occurred at an important time not just for the evolution of automated geographic information systems, but for the evolution of thinking about and the practice of planning metropolitan regions. Simply stated, RLIS created conditions that enabled a sophisticated and now much-studied approach to metropolitan growth management to emerge. Without the willingness to engage in regional planning, however, RLIS would not have developed to the extent that it has. There has been and continues to be a reciprocal relationship between RLIS and Metro's regional planning program.

In this paper, we discuss the development, use, and maintenance of RLIS, illustrating its importance for both the practice of regional planning and the advancement of planning research. We begin with an overview of planning at Metro, since it is that context that provides RLIS with much of its local and political meaning. We then examine the relationship of RLIS to specific Metro planning activities. We conclude with some thoughts about what RLIS has meant to the region and the practice of growth management.

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<sup>1</sup> Exceptions include Vernez-Moudon and Hubner (2000) and Knaap (2001), who describes RLIS as "perhaps the most highly advanced geographic information system and planning [support system] available for any U.S. metropolitan area. "

## **Growth Management in Metropolitan Portland**

Understanding the evolution of RLIS as a tool for planning and policy analysis requires a brief introduction to regional planning at Metro, the context for much of RLIS development. The modern era of regional planning in the Portland region, at least on the Oregon side of the Columbia River, began with the passage of Oregon's landmark statewide planning legislation. The passage of that legislation in 1973, and subsequent efforts over the next 18 months to develop statewide planning goals, handed new planning responsibilities to Metro's predecessor, the Columbia Region Association of Governments (CRAG).

CRAG was a council of governments in the style of many similar organizations created in the late 1960's and early 1970's in the United States (Abbott, 2001, 158). It inherited the work of the old Metropolitan Planning Commission, which in the mid-1960s was the first to try to frame growth and development scenarios for the entire bi-state metropolitan region. Following the passage of Senate Bill 100, the statewide land use planning act, in 1973, CRAG was handed responsibility for establishing and managing a regional urban growth boundary.

The passage of statewide planning legislation, and the requirement for an urban growth boundary around all incorporated places and unincorporated urban development in Oregon, created the conditions for the successful implementation of the urban growth boundary concept. Goal 14, Urbanization, in the Oregon statewide land use planning program, calls for the creation of urban growth boundaries to create an orderly transition from rural to urban land use. Establishing an urban growth boundary occurs through the application of seven factors addressing first the need for urban land, how much and what kind, and then the location for urban development, where and with minimal impacts on farm and forest uses (Knaap and Nelson, 1992, 41).

The drafters of the goals recognized that in a metropolitan area, like the Portland region, the metropolitan scale of the urban land market meant that it made little sense for the 24 mostly contiguous cities and parts of three counties to have their own urban growth boundaries. Though CRAG, and subsequently Metro, was not given the power to engage in comprehensive land use planning, it was given the responsibility for establishing and managing a metropolitan urban growth boundary on behalf of the comprehensive plans of the cities and counties within the urban growth boundary. CRAG was also given the task of coordinating the plans of the individual cities and counties with each other.

In the early days of the implementation of the statewide planning program, the notion that CRAG would have a hand in local land use planning was viewed as redundant at best and threatening at worst, especially in an environment where local planning was fraught with its own tensions and ambiguities due to new involvement of the state in heretofore local planning actions. In this environment, a ballot measure to create Metro out of a merger of CRAG and the old Metropolitan Service District, found receptive ears, especially with a ballot title that read "Abolish CRAG/Create Metropolitan Service District." (Abbott, 2001, 160)

The ballot measure creating Metro was approved at the polls in 1978 and the Metro Council convened for the first time in 1980. Metro assumed the plan coordination activities of CRAG and one of the first actions of the Metro Council was to establish the metropolitan urban growth boundary on the Oregon side of the Columbia River. That boundary was derived from the work done by CRAG, all of which was done by hand and recorded on quarter section maps. Until the development of RLIS, the urban growth boundary only existed on those hand-drawn quarter section maps, and the set of maps was kept updated with whiteout and zipitone. There was one set of blueline maps in several large binders for day-to-day use, and a pile of mylar originals constituting the only record of the boundary. The urban growth boundary adopted by Metro never had a legal description. One fire at the Metro offices would have wiped out the only record of the boundary.

### **The Regional Land Information System**

Metro began developing RLIS in 1988; it was designed to be an urban planner's GIS, incorporating data essential for urban planning and growth management. Designing RLIS was a collaborative effort, involving regional, county, and city planners. The objective was to identify the data and functional requirements of a GIS supporting community and regional planning. Its region-wide usage for planning and environmental management was to provide consistent land information across jurisdictional boundaries for GIS programs in government and business, enabling data exchange and sharing of maintenance responsibilities.

#### **Critical Steps in 1989**

Before launching into full development, a pilot project was performed to test feasibility, identify data requirements, data availability, production methodologies, and estimate production man-hours. The original project was estimated to require over two years of in-house staff time for development of the 544-square mile GIS. By contracting with a consulting firm, development time was reduced by 10 months, delivering an operational GIS early in 1991.

The first and primary task facing the design group was choosing a base map. For GIS this means defining the basic unit of measure (mother geography). Two measurement units were considered: tax lots and zonal polygons (e.g. census tracts or traffic analysis zones-TAZ). Regional planners preferred a zonal system as the least complex and costly. Conversely, local planners expressed their need for a tax lot based system. They were concerned that a larger unit, such as census tracts or block groups, would restrict use of the new GIS to broad area planning. Tax lot level acuity is often necessary for community scale planning, and linking tax lots to county assessor records in a GIS was highly desired. The group's decision to offer this capability became a persuasive selling point later, encouraging the financial participation of local governments in the RLIS project.



The primary concerns of regional planners with a tax lot base stemmed from its inherent complexity, large file sizes and cost of upkeep. They had been warned about the risks of such an ambitious GIS venture by a local university professor, who suggested considering a point-in-polygon system for linking tax lot records to a digital cadastral map, significantly reducing file size and the computational complexity of using tax lot topology.

In the end, the deciding factor was the need for local jurisdictions' financial support, which were willing to share the cost of a GIS, providing it fulfilled their needs. Therefore, since a tax lot based GIS met everyone's needs, the regional planners agreed to take on the daunting task of building such a complex system. Ultimately, this was fortunate, as Metro is now highly dependent on tax lot level acuity. For example, Metro's innovative land use forecasting model, MetroScope, would not be feasible without spatially linked tax lot data.

The primary hurdle to developing a tax lot base was obtaining digital tax lot boundaries. Fortunately, the region's electrical utility, Portland General Electric (PGE), had recently digitized tax lots for its five county service area. Three of these counties were in the Portland metropolitan area. Clark County, Washington, data became available for RLIS when the county developed a GIS in 1992. PGE initially put a price tag on its tax lot layer that would consume 50% of the first year's RLIS budget, excluding personnel costs. Several months were spent negotiating a quid pro quo arrangement, wherein Metro received PGE's CAD file (at no charge) in exchange for returning it in GIS format. PGE management realized the value added to their CAD system and, with Metro committed to quarterly updates, the cost of maintaining the land base in the three Portland counties would fall to Metro.

A contractor was selected for the CAD to GIS conversion and following a 16-month effort, a tax lot base for RLIS and PGE was born. A major portion of the conversion work involved assigning tax lot I. D. numbers to each polygon. These unique identifiers provided the spatial link to land appraisal and other linked records. Each of the three counties, Washington, Clackamas and Multnomah, agreed to provide tabular tax assessment records. For the first few years, Metro did all tax lot line maintenance, monthly updating using assessment records. However, as the counties developed in-house GIS capabilities, they assumed responsibility for tax lot line maintenance. This transition is complete for two counties and a third is expected to take over tax lot maintenance in 2003.

In addition to the tax lot base map, planners needed the ability to match addresses to street centerlines and perform other functions requiring a street network. To fill that need, a base layer of streets and addresses was developed. The U.S. Census Bureau's 1990 TIGER line file served as the base for this project. Streets are now the alternate base layer in RLIS and are used for transportation, vehicle routing, thematic mapping, and display/analysis of zonal information such as census data and transportation information for transportation analysis zones (TAZs).

Since its initial development, the streets/address layer has been continually improved, using data from state, regional, and local sources. Street address records from PGE meter service locations and 911 responders have aided in development of a master street address file. Currently, Metro is conducting a major upgrade to the file's accuracy, using a grant from the State Office of Emergency Management.

### **Key data elements**

Having selected the base maps for the foundation of RLIS, planners developed additional data layers. The primary layers are presented in Table 1. Each of these layers reflects a combination of needs for regional planning and availability of regional data. Since its launch in 1991, the number of RLIS layers has grown from 19 to more than 100. The current RLIS metadata can be viewed on the Web at: <http://mazama.metro-region.org/metadata/>.

### **The Vacant Land Layer**


Because a primary purpose for RLIS is monitoring land development and future growth capacity, measurement of available land is a primary criterion for success. Given persistent controversy over land supplies, the accuracy and detail of the vacant land layer is critical. For this reason, aerial photography is the primary source for identifying vacant land. Each year Metro purchases true color digital ortho-rectified<sup>2</sup> aerial photography for the region. Aerial photography interpretation was first used by Metro in 1991 to develop an inventory of vacant land, using 1.2-FTE person hours. Developing the inventory required inspecting each photograph, overlain with the half-million tax lots within the Portland metropolitan area.

Each year two GIS technicians spend two months updating the inventory, overlaying current building permit records over aerial photos. The interpretive decisions they make are rule-based and intentionally limited in order to control any bias they might introduce. They must only determine whether a tax lot is vacant or partly vacant or developed. No consideration is given at this point to suitability for building, zoning, redevelopment potential, or any other criteria. These determinations are made in subsequent steps in the production of the buildable lands database. The inventory is an annual development snapshot using July photography. It is not updated between annual aerial flights.

Each tax lot is given one of four attributes: vacant, partially vacant, underdeveloped or developed. At this stage, no consideration is given to whether the land is buildable. That is, environmentally constrained from development, due to hazards or protective regulations. These rules have remained unchanged for the 11 years Metro has been monitoring vacant land with the GIS.

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<sup>2</sup> Ortho-rectification provides a three dimensional correction of the photography so that the photo is "draped" over the landscape, providing improved registration of the photos to the ground and to other GIS layers.

- 1) Vacant tax lots have no structures, appreciable improvements or identifiable land use.
- 2) Developed lots have improvements and specific land uses. For example, a paved parking lot is developed but an unpaved lot is vacant, even though some equipment may appear to be stored there. Parks and open spaces are treated as developed, being unavailable for development.
- 3) Partially developed lots have 1/2 acre or greater of vacant contiguous area. The vacant portion is added to the vacant land database
- 4) Lots under site development in an initial stage of development (such as road grading and earth movement), but development is substantially incomplete and they are therefore considered vacant. 

Because many developed lots have vacant land remaining to accommodate further development, a method for identifying partially developed lots was devised. To assure that the remaining vacant land was of adequate size to actually support further development, the “half-acre rule” was adopted. Examining these parcels led to the conclusion that one-half acre was the logical and practical minimum for addition to the inventory. Figure 1 shows the application of this rule to partially developed lots with more than ½ acre of remaining vacant land.

However, Metro recognized that areas of less than one half acre could support development. Therefore, to reconcile this under-count potential, Metro conducted supplemental in-fill surveys of residential and non-residential lots. A projected rate of in-fill development is now factored into growth capacity calculations.

As shown in Figure 2, Building permits used in the vacant land study are limited to new construction over \$50,000 to exclude permits for remodeling and alterations. The permits are mapped as indicators, but are not totally reliable in pinpointing every newly developed lot. Therefore, close scrutiny of the aerials is necessary to identify every lot developed since the previous year’s inventory.

### **RLIS and Growth Management**

There was not a lot of interest in growth management at Metro for most of its first decade. Oregon entered into a long and protracted recession, severely dampening the growth pressures of the 1970’s that led to the creation of Oregon’s statewide land use planning program. However, there was significant interest in transportation policy and planning, especially with the cancellation of the Mt. Hood Freeway project and the reprogramming of the Federal funds allocated for that purpose to transit and other projects in the metropolitan area. Starting in the early 1980’s, Metro began to develop models and forecasts needed to support the four-step transportation planning process embedded in Federal transportation planning requirements.

The recession of the 1980's led to a number of attempts to stimulate the economy through managing the urban land supply. A major amendment of the urban growth boundary to add large parcels for industrial, mostly high tech development had little immediate impact on either the nature or extent of economic development. Metro's enabling legislation did not give it the authority to develop comprehensive plans of the kind developed by cities and counties, but it did provide Metro with functional planning authority, the ability to develop plans addressing specific aspects of metropolitan systems and land use.

Further, Metro was given the authority to require local comprehensive land use plans to incorporate changes to be consistent with regional functional plans, an incredible power delegated to a regional agency and found, for the most part, nowhere else in America. However, the relative lack of growth pressures, and the significant lack of interest in land use planning among Metro elected officials, meant that there was little interest in or pressure for Metro to engage in much more than transportation planning for most of the 1980's. Though Metro was actively engaged in planning the region's solid waste management system during this time, and though siting decisions for waste management facilities proved to be controversial and contentious, Metro had little involvement with the formal land use planning program established throughout Oregon.

In the late 1980's, things began to change. Both economic and population growth in the region began to pick up. Further, consistent with statewide planning law, Metro was required to undergo "periodic review" for its urban growth boundary. By 1988, Metro could no longer put off its periodic review for the regional urban growth boundary. By this time Metro's land use planning staff had been reduced to one half-time position.

However, new growth pressures raised new questions about the urban growth boundary. Outside the boundary, farmers were wondering whether the next expansion would take their land. Inside the boundary, urban development was beginning to resemble the kind of development that the statewide planning program had been designed to avoid. On the boundary line itself, there was no indication where and under what circumstances the line would move, raising questions for urban service providers trying to size facilities and communities trying to anticipate further growth needs and opportunities. In short, urban growth was becoming a regional issue. Regional growth management seemed to make some sense, though precisely what that meant was not at all clear.

### **RUGGO and 2040**

A long-overlooked provision in Metro's enabling legislation called for the development and adoption of "regional goals and objectives." This unaddressed duty was appropriated within the periodic review process for the urban growth boundary to support the development of the "regional urban growth goals and objectives" (RUGGO). Starting in 1989, Metro engaged in a process to develop the RUGGO and meet the requirements of periodic review.

RUGGO was adopted in 1991. At the same time, suburban governments were engaged in visioning exercises to update their own comprehensive plans and better articulate

community aims. Through the leadership of suburban mayors and county commissioners, the Metro Council was convinced that its RUGGO was a good start but fell short of a regional vision. As a result, Metro and the jurisdictions began the development of the Region 2040 planning process in 1992, leading to the adoption of the 2040 growth concept, a 50-year vision for urban growth within Metro's boundaries, in late 1994.

RLIS began its development at almost the same moment as the work began on RUGGO, and the first RLIS products became available at about the same time that RUGGO was adopted in 1991. For both efforts, the timing was right. The region was ready to entertain notions of urban growth management, and the technology and digital parcel base map were ready for RLIS. In addition, both efforts depended tremendously on the cooperation of regional partners. Like RLIS, the Region 2040 effort began as a public/private partnership. Both efforts came about because of collaboration, careful attention to building the regional community of interest, and an understanding that strong working relationships were required for success.

Key to the development of the 2040 plan was the development of a base case and three alternative growth concepts (scenarios). (See Appendix 1) The guiding principle was to develop a set of plausible alternatives that would delineate the territory within which an acceptable preferred alternative capable of being implemented would be found.

In concept A, 50 years of growth would be accommodated by some expansion of the existing UGB, the construction of three new highways and a high-capacity rail system, and increasing densities along light rail and bus lines.

In concept B, the same amount of growth would be accommodated with no expansion of the UGB, no new highways but a more extensive light rail system, and significant increases in density along light rail lines and bus stations.

In concept C, termed the "satellite city" concept, one third of expected growth would be accommodated in neighboring cities, with three new highways and a moderate amount of transit, and little increase in density.

Using RLIS to drive transportation and air quality models using parcel level data for the first time, Metro discovered that none of the concepts alone offered the ideal growth management strategy — none, for example, could prevent increases in congestion. Each concept, however, and the data-driven insights that it offered proved useful in developing an acceptable growth strategy. Table 2 summarizes a number of the measurable differences between the alternatives and the preferred alternative as would be expected in the year 2040.

### **A Series of "Firsts"**

In addition to developing a parcel-level base to support modeling and analysis, RLIS provided regional planners with a number of "firsts" essential for supporting the Region 2040 planning effort. It provided the first parcel-level base map for the region, showing the impact of the urban growth boundary in bold relief, region-wide, for the first time. It

provided the first composite comprehensive plan and land use maps for the metropolitan region. It provided the first data on rural and southwest Washington land cover and land use plans on the same maps showing the territory inside Metro's boundaries. It enabled the development of a complete set of "McHargian" overlays. Finally, it provided the basis for creating new tools for citizen involvement, including real-time experiments showing the impacts of user-defined land use policy choices.

Meanwhile, Metro worked with the legislature to refer a constitutional amendment allowing home rule charters for metropolitan service districts to the voters. The measure passed in 1991 and the Metro Council appointed a charter commission. A charter was referred to the voters and approved in 1992. With the pace of growth accelerating in the metropolitan area, growth management was identified as the most important role for Metro. The charter called for the creation of a long term Future Vision, and a Regional Framework Plan that would be a collection of regional functional plans that would echo the RUGGO and ultimately replace it, addressing the urban growth boundary, transportation system, rural land protection, and housing densities, among other topics. The Regional Framework Plan was adopted in 1997, incorporating the Regional Transportation Plan, 2040 Growth Concept, Regional Urban Growth Goals and Objectives, and the Urban Growth Management Functional Plan (adopted in 1996 to implement the 2040 Growth Concept).

The impact of these developmental stages is most apparent in the development and ongoing management of the Region 2040 Growth Concept. (See Figure 3.) Region 2040 is an urban structure plan, not a regional comprehensive plan. It identifies key places in the metropolitan area. It provides a plan for a transportation system to knit those places together. It provides guidance for the long-term management of the urban growth boundary. Finally, it integrates a system of greenspaces into the urban mix.

RLIS supported this effort initially through the provision of inventory maps used centrally to identify possible alternative scenarios. Overlay techniques were used extensively to combine and recombine data. Interactive land use and transportation modeling applications were used with planners, decision makers, and the public to show the impacts of decisions, and to spawn dialogue and debate about future courses of action.

### **UGB Management**

Perhaps the *raison d'être* of RLIS and much of the data development and forecasting efforts at Metro is managing growth using an urban growth boundary. When the UGB was first drawn with those hand-drawn quarter section maps and maintained with whiteout and zipitone, the accounting used to measure development capacity was equally crude. As described in a 1979 Metro report, vacant land supplies were measured using an area calculation dot screen. The process involved a square grid laid over aerial photographs in which the number of squares in a parcel were hand counted. Given the state of technology, and the politics of the land allocation process, the UGB created in 1979 included so much land beyond even the overly optimistic growth projections of the

time that Metro had to invent the notion of a 15 percent market factor to provide justification to the state for the total area included within that initial boundary.

Because the region grew slower than expected, and because the UGB contained enough land to accommodate in excess of 20 years of growth, there was little concern about land supplies until the 1990s when the rate of growth rapidly accelerated. The legislature passed a law in 1995 that required all UGBs to contain a 20-year land supply for meeting residential development land needs at every periodic review. Faced with these new requirements and under increasing scrutiny by the local and national development community, the complexity of Metro's land accounting task increased dramatically. Fortunately for Metro, RLIS was available to meet the challenge.

By the time the 1995 law went into effect, Metro had established a well-defined and consistent method for determining whether the UGB contained enough land to accommodate 20 years of growth. The method begins with the vacant land inventory (described earlier), and then through a sequence of subtractions land is removed from the inventory that is environmentally sensitive, owned by state, federal, or local governments, or already in platted subdivisions. Then, dwelling unit and employment capacity is computed by overlaying comprehensive plan designations of each local planning jurisdiction. From this total, land and development capacity is removed for streets, schools, parks, and other social organizations; for "underbuild" (because actual development density is usually less than planned density), and ramp up (to allow time for local plans to become consistent with the 2040 plan<sup>3</sup>). Initially, capacity is added for infill, redevelopment, and development in already platted subdivisions. Table 3 provides a summary of the steps used to calculate capacity;

Table 4 presents estimates of capacity by 2040 plan designation.

After estimating development capacity, Metro estimates development demand. This starts with a regional econometric model that produces estimates of population and employment for a specific year. From this estimate, Metro estimates the percent of population and employment that will occur within the UGB and then projects the demand for dwelling units and nonresidential land. After comparing estimates of the demand for and supply of land, it presents to the Metro council recommendations for UGB expansions. If the council decides to expand the UGB, Metro conducts similar exercises to identify where expansions should be made.

Though Metro's methods are logically simple, and not much different from what is recommended in many planning textbooks, each step in the procedure requires the incorporation of key parameters. These parameters include the following:

- Capture rate: percent of employment and residential growth to occur inside UGB;
- Gross-to-net: percent of land needed for schools, streets, and parks;

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<sup>3</sup> Ramp up is no longer considered.

- Underbuild: percent of maximum density at which development will actually take place;
- Refill: Amount of development that will occur on already developed land and on partially developed parcels of less than one-half acre that are not accounted for in the vacant land inventory;

2040 designation capacity: amount of employment and dwelling unit capacity in 2040 plan designations. (Residential capacities are computed from the densities allowed per zone by local jurisdictions. These densities must provide the capacities required by Metro's functional plan, but are determined by local land use regulations. Employment densities are determined according to the land use designation and FAR's developed by Metro staff.)

As demonstrated in sensitivity analysis conducted by Metro the values of these parameters have profound impacts on estimates of development demand and supply. The values of all these parameters are chosen based in part on historical patterns, staff judgment, and council policy. But it is impossible to overstate the role that RLIS plays in the estimation of these parameters or the overall management of the UGB.

### **Policy Analysis**

Though RLIS was developed primarily to support planning and decision-making at Metro, it has been used by a variety of consultants and scholars for policy analysis and research. Perhaps not surprisingly, most of the research based on data from RLIS has been conducted by Metro staff, Metro contractors, and scholars associated with Oregon universities. The RLIS-supported research on these topics has not only helped shape land use policy in Oregon, but has made major contributions to the scholarly literature on urban planning and policy analysis.

Largely because the impacts of Portland's UGB on land and housing values has been so controversial, the most widely known research that uses RLIS is research on the UGB. Some of this work predates RLIS (Knaap 1985, Nelson 1988), but RLIS has made the work easier and more accessible. Because RLIS includes parcel boundaries and assessor's data, it facilitates the combination of information about parcels, such as assessed land values, assess improvement values, sales values, property taxes, etc., with regulatory and environmental variables, such as zoning, comprehensive plan designation, location with respect to the UGB, floodplains, wetlands, slopes, and distance to virtually anything.

In a widely discussed and controversial report funded by Portland homebuilder Don Morisette, Mildner et al (1996) used RLIS data to examine changes in development densities and property values in Portland using the preferred alternative for the Region 2040 Growth Concept and Metro's 2015 growth forecast. Their conclusions, that the UGB would be responsible for higher housing prices and increased sprawl, led to considerable debate about the future of the UGB both in Portland and around the nation. Further work by others (Phillips and Goodstein 1998, Knaap 2001, Lewyn 2002, Downs



2002, and Nelson et al 2002) have since cast doubt on and refuted the central findings of this report.

Data from RLIS has also been used to examine the effects of Portland's light rail system on property values. Early work on the impacts of the eastside light rail line also predated RLIS (AL-Mosaind et al 1993). More recent work by Chen et al (1997) used a much larger data set and isolated the impacts of proximity to the boundary line from proximity to the stations using GIS operations to isolate the benefits of accessibility from the imposition of nuisance. Chen et al found house values increased with proximity to the stations but fell with proximity to the line. Here again, RLIS facilitated the combination of property data with detailed spatial data.

More recent work on the effects of the Westside light rail system was conducted by Knaap et al (2002). This study sought to identify the effects of announcements about the station locations before the line was actually put in operation. They found that land values within one and one-half mile of the station locations increased following the announcement of the station locations. This work was made possible by the fact that the assessment data in RLIS has specific dates of sales.

RLIS was developed in large part to improve land use policymaking, and an obvious way to do so is to examine the effects of policy on land use. Much of this kind of analysis, though often informal, has been conducted in-house by Metro. Some of the larger tasks have been contracted out—often to ECONorthwest, a Eugene, Oregon consulting firm.

ECONorthwest (1990, 1996, 1998, 2001, 2002) has conducted a variety of analyses using RLIS data. These include analyses of the population and employment capacity in urban reserve areas (1998), an evaluation of policies for guiding development inside urban growth boundaries (1990) and a market and regulatory analysis of growth (1996). In this latter study, ECONorthwest used RLIS to evaluate current development patterns, recent development trends, and anticipated development forms to identify sources of and solutions to regulatory problems faced by developers. RLIS provided essential base information for a forum at which developers and real estate professionals commented on constraints and opportunities (both long-run and short-run) of each site that RLIS had identified as "buildable."

The effects of investments in light rail (the Max) on land use have been explored in some detail. Thompson and Song (1999) showed that the Max had significant effects on land values and sales activity on the west side of the metro area while almost no impacts on the east side. Peng et al (1996) combined RLIS data with data from the American community survey to examine differences over 10 years in auto ownership, mode share, density and property values between a bus and a transit corridor on the east side. They found that in the light rail corridor automobile ownership grew slower, transit mode share increased faster, and single family property values grew faster than in the bus-route corridor. They found small differences, however, in multifamily housing share or dwelling unit densities. Central to these studies is the capacity to buffer transit routes and station areas and the ability to spatially interpolate data with disparate underlying spatial units of analysis.

RLIS has also been instrumental in research on the effects of land use patterns on transportation behavior. Duecker and Bianco (1999), for example, examined the effects of parking charges on transportation mode choices in urban and suburban residential locations. Using data from a household activity survey conducted by Metro, and geocoding activities using RLIS, Duecker and Bianco found that mode choice on the journey to work was affected by parking charges, especially for suburban residents driving alone.

Using RLIS and data from the Tri-Mets Bus dispatch database, Kimpel (2001) also examined the effects of transit service reliability on bus passenger demand at the time-point level of resolution. He found that improvements in service reliability—arrival on time at specific locations—increased service demand, but that socioeconomic and land use characteristics are more important than factors directly under control of the transit agency.

Recent work by Rajamani et al (2003) offer corroborating evidence. Using RLIS to calculate detailed measures of urban form at the neighborhood level, this team found mode choices for non-work trips also strongly affected by land use characteristics such as density, connectivity, and pedestrian accessibility.

## **Modeling**

RLIS has enabled development of an integrated land use/transportation urban activity simulation model: MetroScope (Conder 2001, Conder and Lawton 2002). RLIS and MetroScope are proven tools for addressing Metro's chartered and state mandated responsibilities for the region's urban growth boundary. MetroScope integrates four models and RLIS land information to simulate future land development/redevelopment. Visual representations of model outputs are produced through the linkage to RLIS. The four models that interact within the MetroScope framework and include:

- The **GIS database and tools** contain the land and development data inputs and maintain the spatial relationships between data elements.
- The **economic model** predicts region-wide employment by industry and the number of households in the region by demographic category.
- The **travel model** predicts travel by mode (bus, rail, car, walk, or bike), road counts and travel times.
- The tandem **real estate location models** for residential and non-residential location predict the locations of households and employment; also the amount of land to be consumed by development, the amount of built space produced, and the prices of land and built space by zone in each five-year incremental iteration.

MetroScope allows the testing of a wide range of growth management policy scenarios. The model's primary inputs are:

- **Land Availability and Capacity**, including zoning and plan designations, environmental constraints, and the parameters to identify land that will be developed. RLIS is the primary source for these model inputs.
- **Cost of Development**, including specifications of cost per square foot to build.
- Assumptions about **changes in demographics** (income, age, and household size) which are applied through the economic model, as well as assumptions about **changes in employment** (by industrial sector).
- Assumptions about **changes in transportation infrastructure and transit availability** are applied through the travel model.

Metro is currently using the land information in RLIS and MetroScope policy scenario simulations to determine the amount of land required to accommodate the next 20 years of growth and where to expand the UGB. Six policy scenarios were developed and modeled for input into the decision making process. The recent expansion decision is shown in Figure 4.

Transims is a new travel simulation model the U.S. Department of Transportation has contracted with Los Alamos Lab and Metro to develop. It represents a new paradigm in modeling, known as a micro-zone simulation model. The micro means it is modeling travel on a much finer level (city blocks for instance) and simulates traffic in near real time. Such robust models require considerable data inputs for very small geographic units. The U.S. Department of Transportation chose Metro to team up with Los Alamos because of RLIS, which they saw as providing a rich land information base for a metropolitan area within the country and Metro's reputation for model development and operation. A description by U.S. DOT can be found at <http://tmip.fhwa.dot.gov/transims/>

### **Private Sector Use**

RLIS has moved beyond its original purpose and has gained a broader user base in the community. Local governments and real estate developers are the two largest user groups. Cities and counties have incorporated the data into their planning information database and developers use the vacant lands inventory to find land available for construction. Other users include environmental groups, neighborhood associations and sundry organizations that benefit from vacant land information.

In recent years, Metro has been automating its services for the public, providing web access for a variety of products. A product known as "RLIS Lite" has been developed for community users, and one of the interesting byproducts has been the rise of the "citizen cartographer" in the 1990's as data, software, and computing power became more widely available and affordable. RLIS Lite is distributed quarterly on CD ROM to a subscriber base of 150. An annual subscription is \$895 and the price is reduced by 50 percent for governments and non-profits and 95 percent for educational institutions. A companion CD ROM has aerial photography and costs \$500.

In addition to providing GIS data, standard and custom map products are available, as are research consulting services. Sale of products and services generates from \$300,000 to \$400,000 a year. The RLIS Lite subscription is the single largest revenue producer, averaging \$100,000 per year. Funds generated by the sale of products and services are dedicated to data maintenance.

Nonetheless, Metro's priority for the development of RLIS was to serve its regional planning and analysis needs. RLIS is housed within Metro's Data Resource Center. Within the center, Metro has identified three audiences for its work. First are Metro departments, with 50 to 60 percent of the RLIS staff dedicated to meeting internal data and mapping needs. Second are Metro's partner jurisdictions, to whom Metro commits approximately 30 percent of its RLIS staff resources. Finally, the general public is the third group identified by Metro as a constituent for RLIS services, receiving about 10 percent of the staff resources.

### **Maintenance and Development**

The development and effective use of a comprehensive information system such as RLIS requires a long-term commitment. As valuable as RLIS is to any one project, the costs of data and system development are uneconomical unless spread over many different projects. The diffusion of costs and enlargement of benefits are enhanced by the involvements of many departments and local jurisdictions. Finally, in the rapidly evolving field of GIS, standing still is not an option. As the quality of data, operating systems, and computer platforms continue to advance, Metro strives to keep RLIS at the forefront of GIS technology.

### **Multi-jurisdictional Participation**

The development of RLIS involved integrating data from the region's cities and counties into an integrated whole. A decade ago, the only data in digital format were the tax lot lines available from PGE. Local governments provided paper maps and Metro, with the assistance of a contractor, digitized them using the tax lot lines as the reference base.

Following digital conversion of the core RLIS layers, cooperative agreements were developed with local governments for development of ancillary layers and the ongoing maintenance of all layers. These agreements emerged from RLIS user gatherings, where the principle was developed that the agency bearing the greatest risk from errors in a particular layer, should have responsibility for its maintenance and accuracy. For example, the property tax assessor is the logical maintainer of cadastral information and the planning departments of property zoning.

A responsibility matrix was negotiated and has become an informal contract, establishing each jurisdiction's role and responsibility for RLIS (see Table 5). For each layer, RLIS members are indicated as a developer, maintainer or user. Of course, a member can be included in all three categories, Metro being the primary example.

## **Migrating to More Accurate GIS Data**

Metro has moved from being the sole maintainer of the region's GIS to an integrator of updated and improved data received from other governments. As local governments have developed GIS programs, they have taken over maintenance of their specific data. For example, shifting tax lot maintenance from Metro to the counties has been especially valuable. However, we have discovered that integrating the data into an integrated regional system is a challenge, but is facilitated by virtue of all jurisdictions using the same data model instituted for the region by Metro.

A primary benefit of this integration strategy is incorporating investments made in GIS accuracy by local governments into RLIS. For example, the positional accuracy of the tax lot and street base maps are being systematically improved by local governments, as digital spatial data becomes more integrated into their business operations. This integration is greatest in public works, tax assessment and planning departments. GIS layers are also being improved over time; for example, in 1996 the parks and open spaces inventory was updated, adding some 2,000 acres to the parks database and simultaneously deducting it from the vacant land inventory.<sup>4</sup>

This cooperation has required close intergovernmental cooperation, with Metro staff regularly convening the Regional GIS Steering Committee to establish standards, promote information exchange and annually form a consortium to share the cost of aerial photography. These efforts have paid off, resulting in a collegial GIS community that shares information and knowledge. For example, the local GIS community sponsors an annual three-day GIS conference that draws over 300 attendees from Oregon and Washington.

## **Conclusions**

The development of the Regional Land Information System was purposeful and not solely for the love of GIS. It was developed as a means for better planning and policymaking, improving both the efficiency and quality with which Metro managed planning data. In addition, it was directed at providing Metro and its partners with greater insight regarding issues such as the monitoring and management of the urban land supply, and keeping up with rapidly evolving concepts in transportation planning, particularly the linking of land use and transportation planning to achieve more complex ends. RLIS development also had the ancillary benefit of creating a common frame of reference for assessing and portraying regional conditions.

When reviewing the planning activity of the first decade of RLIS' existence, two observations can be made. First, the forces that enabled Metro's regional planning to widely engage issues of urban growth management led to the creation of a regional urban growth concept despite the presence of RLIS. What RLIS contributed was both new

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<sup>4</sup> The majority of this change resulted from Metro's purchase of open spaces, enabled by a \$135,000,000 bond measure approved by the voters within Metro's jurisdiction.

mapping and analytical tools that enabled the growth concept to emerge at the parcel rather than the generalized “bubble map” level.

RLIS has proven to be a successful and highly useful product. Its envisioned purpose as a region-wide information system for planning and growth management has been met and exceeded, providing capabilities not originally contemplated. In 1997, the system was privileged to be selected from a national and international field of candidates to receive ESRI’s exemplary GIS award.

Some project success factors include:

- The emergence of robust GIS software in the ‘80s: ESRI’s Arc/Info GIS.
- Availability of digital tax lot lines from the region’s electric utility - PGE (Portland General Electric).
- Region-wide GIS standards were established early on and subsequently adopted by local jurisdictions and other RLIS users.
- Cooperative data sharing with local governments from the beginning.
- Metro’s role as a regional government to coordinate development of regionally consistent land information and transportation modeling.
- State mandated local government funding for Metro’s growth management program until 1993.
- State mandated regulatory responsibilities, requiring comprehensive land information and mapping capabilities.
- A suburban/urban political partnership addressing growth management and transportation planning.

Passage of state legislation allowing market pricing for RLIS products to partially offset maintenance costs.

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## Appendix 1

### Discovering the choices

From 1992 to 1994, Metro used urban development analysis tools and forecasting technologies to study different growth management strategies. A wide range of possible approaches were identified and analyzed for impacts to the region's neighborhoods, transportation system, natural resources and key urban services. This intensive study, originally called Region 2040, allowed Metro to focus on a number of options to prepare for local jurisdictions and the public to review. Metro ultimately tested four scenarios for how the region could grow.

Each option was analyzed for effects on:

- land consumption
- travel times and distances
- open spaces and air quality
- various urban landscapes.

The four options, called "growth concepts," presented different philosophies about how the region should actively manage growth.

#### Base case - Continuing pattern



Greatest expansion of UGB; continuation of development patterns occurring between 1985 and 1990.

354,000 acres in UGB  
(121,000 acres added to UGB)

*"Growth concepts" presented different philosophies about how the region should actively manage growth.*

#### Concept A Growing out



Significant expansion of the UGB; new growth at urban edge develops mostly in the form of housing.

284,000 acres in UGB  
(51,000 acres added to UGB)

#### Concept B Growing up



No UGB expansion; growth accommodated through development of existing land within the urban growth boundary.

234,000 acres in UGB

#### Concept C Neighboring cities



Moderate expansion of the UGB; growth focused in centers, corridors and neighboring cities.

257,000 acres in UGB  
(22,000 acres added to the UGB)

### 2040 Timeline

**1991** - Council adopts Regional Urban Growth Goals and Objectives (RUGGOs) as the guide for Metro's long-range planning efforts.

**November 1992** - Voters approve home-rule charter for Metro, making growth management the agency's top priority.

**1992-94** - Region 2040 public involvement and technical analysis process, including development of the alternative concepts for growth.

**Spring-summer 1994** - Major public involvement effort on the growth concept occurs, including television and print advertising, youth activities, open houses and a questionnaire to every household in the region.

**TABLE 1**

**Primary RLIS Layers**

<b>Layer</b>	<b>Description</b>	<b>Source</b>	<b>Update Schedule</b>
<b><u>GIS Base Layers</u></b>			
Tax Lots	Property assessment tax lots	County Assessors	Quarterly
Streets	Streets, highways, bus/light rail lines, bike routes, sidewalks/trails	Local governments, state DOT, Tri-Met	Streets Daily, others periodically
<b><u>GIS Overlays</u></b>			
Vacant land	Vacant tax lots, partially developed lots w/1/2 ac. or more land vacant	Metro, using aerial photography and building permits	Annually
Developed land	Reverse of vacant land layer	See vacant land	Annually
Land use	Derived from tax codes	County Assessors	Periodically
Zoning	Local land use zones	Local Governments	Quarterly
Comprehensive plans	Local comp. plans	Local Governments	Quarterly
Parks and open space	Parks and public/private open spaces	Metro, local govts. and property tax records	Annually
Aerial photography	Natural color ortho-rectified digital imagery	Consortium of governments in region	Annually
Jurisdictional boundaries	Boundaries, e.g. UGB, schools, service dists.	Metro & local Jurisdictions	Quarterly
Places	Hospitals, schools, police etc.	Local Governments	Periodically
Building permit	Location of issued permits	Local Governments	Monthly
U.S. Census	Census data for 1980, 1990 and 2000	US Census Bureau	Decennial
<b><u>Environmental Layers</u></b>			
Rivers, streams, wetlands and watersheds	Location and attribute information for water features	Metro, local, state and federal	As better data is available
Tree canopy and land cover	Urban forest canopy and vegetative/other land cover	Landsat TM digital satellite imagery	Periodically, multiple years
Flood plains	100 Year Flood Plain	FEMA	As better data available
Steep slopes	10% and 25% slopes	Digital terrain model	As necessary
Soils	Soils by type and class	NRCS	As new avail.
Elevation contours	5 ft. elevation contours	Digital terrain model	As necessary
Digital Terrain Model (DTM)	Digital terrain data for geo-referencing of info	Consortium of govts. in the region	As deemed necessary
Earthquake hazard	4 Zones depict relative hazard for urban area	Oregon Dept. of Geology	Non scheduled

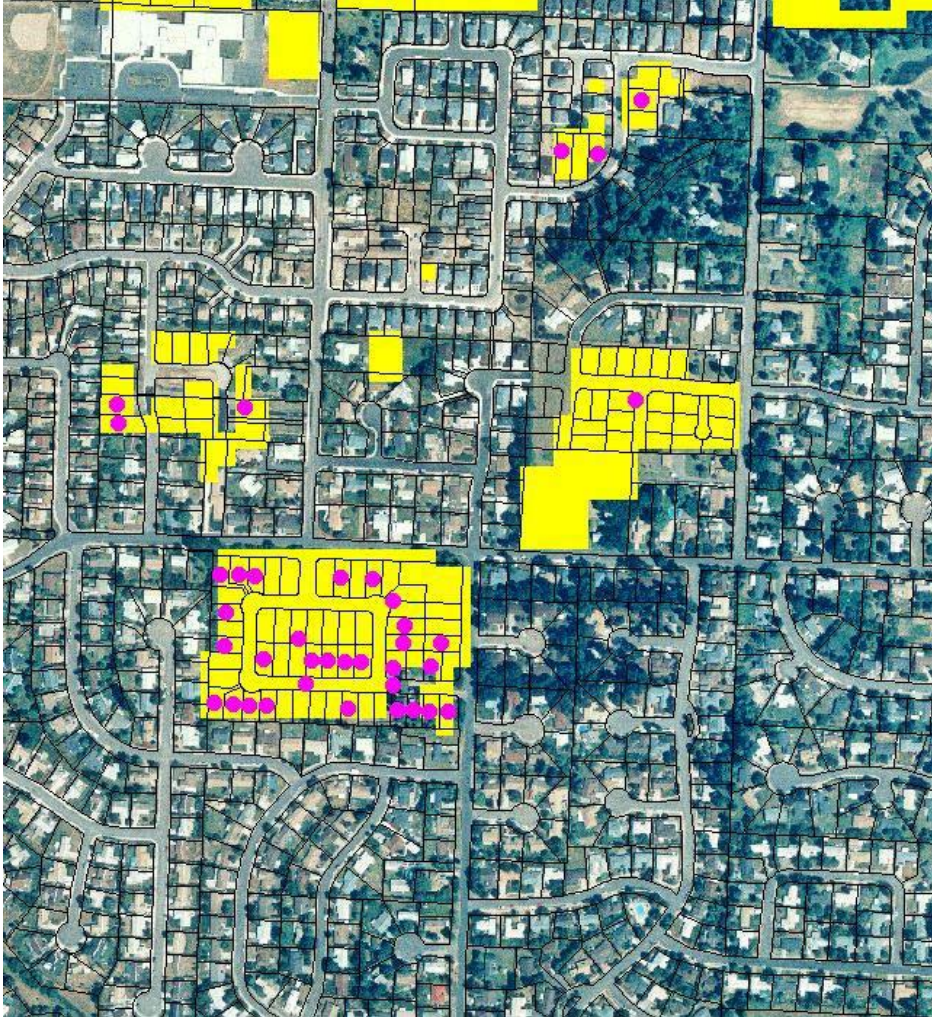
**Figure 1.**

These tax lots have a developed portion, and a vacant portion greater than 1/2 acre.



**Figure 2.**

Recent building permits are displayed over the previous year's vacant land inventory to assist with identifying newly developed lots.



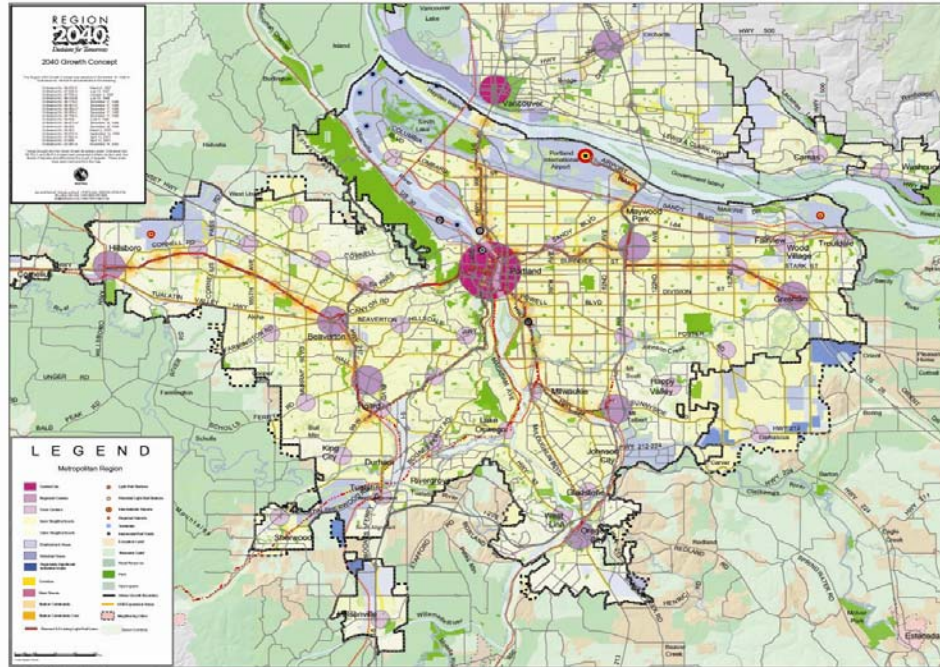
**TABLE 2**

**Important Growth Scenarios**

	<u>1990</u>	<u>Base</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Pref.</u>
Single-family/Multi-family(%)	70/30	70/30	74/26	60/40	69/31	65/35
% Growth in 1990 UGB	100	83	71	100	63	87
% Growth via Redevelopment	---	0	6	18	8	19
Farmland Acres to Urban Use	---	63,900	17,200	0	11,400	3,545
VMT per capita	12.4	13.04	12.48	10.86	11.92	11.76
Mode Split(Auto/Transit/Ped-Bike)	92/3/5	92/3/5	91/4/5	88/6/6	89/5/6	88/6/6
Congested Road Miles	151	506	682	643	404	454
Transit Riders (1000's)	137	338	372	528	437	570

**Figure 3**

**Region 2040 Growth Concept**



**TABLE 3**

**Procedure for Identifying Buildable Lands  
and  
Calculating Housing and Employment Capacities**

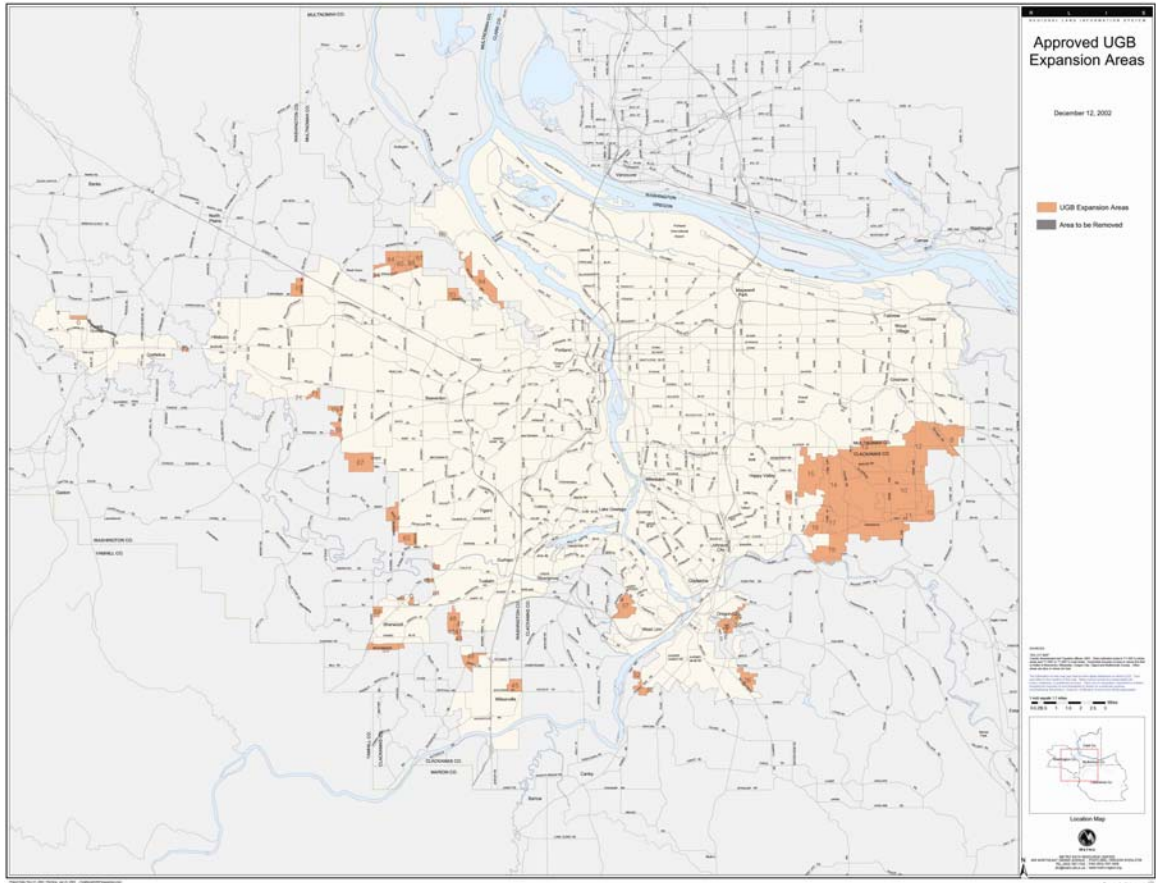
<b><u>Step 1</u></b>	Calculate the total number of acres inside the Metro Urban Growth Boundary (UGB).
<b><u>Step 2</u></b>	Subtract acres of committed and developed land.
<b><u>Step 3</u></b>	Subtract acres of platted, vacant single-family residential land.
<b><u>Step 4</u></b>	Subtract vacant, environmentally constrained acres to arrive at vacant, unconstrained land.
<b><u>Step 5</u></b>	Subtract land for future facilities (streets, schools, parks, churches, fraternal organizations, government facilities) to arrive at net buildable, vacant acres.
<b><u>Step 6</u></b>	Calculate development capacity of vacant land under current comprehensive plans for housing.
<b><u>Step 7</u></b>	Adjust current comprehensive plan capacity for single-family under-build.
<b><u>Step 8</u></b>	Adjust housing for platted lots.
<b><u>Step 9</u></b>	Rezone for 2040 Growth Concept and calculate housing and employee capacity.
<b><u>Step 10</u></b>	Adjust the Metro 2040 Growth Concept capacity for residential under-build.
<b><u>Step 11</u></b>	Adjust the Metro 2040 Growth Concept housing capacity for platted single-family lots.
<b><u>Step 12</u></b>	Adjust the Metro 2040 Growth Concept housing and employment capacity for physical development barriers.
<b><u>Step 13</u></b>	Adjust density assumptions to allow cities and counties time to implement 2040 type regulations (ramp-up).
<b><u>Step 14</u></b>	Estimate redevelopment potential and adjust capacity calculation for housing and employment.
<b><u>Step 15</u></b>	Estimate infill housing on lands categorized as developed, increase employment densities on developed lands and adjust capacity.
<b><u>Step 16</u></b>	Consider the farm or forest use assessment acreage in UGB.
<b><u>Step 17</u></b>	Compare UGB capacity with forecasted 20 year need and determine acres of UGB expansion by land use type.

**TABLE 4****Net Buildable Vacant Areas**

<b>Current Regional Plan Category</b>	<b>Gross Vacant Buildable Acres</b>	<b>Gross-to-Net Reduction</b>	<b>Net Buildable Vacant Acres</b>
Agriculture or Forestry	585	0	585
Rural or Future Urban	1313	(959)	354
Single Family	12,228	(5,136)	7091
Multi-Family	2,340	(890)	1,450
Neighborhood Commercial	151	(15)	135
General Commercial	747	(396)	351
Central Commercial	455	(312)	143
Office Commercial	297	(122)	175
Light Industrial	6,033	(1,157)	4,876
Heavy Industrial	1,630	(989)	641
Mixed Used Industrial	1,680	(723)	957
Park and Open Space	290	(152)	137
Public Facilities	785	(624)	161
<b>Total</b>	<b>28,534</b>	<b>(11,475)</b>	<b>17,056</b>

Table 4 presents estimates of capacity by 2040 plan designation.

**Figure 4**





**TABLE 5**

**Maintenance Responsibility Matrix**  
 Example Addressing a Subset of RLIS Layers

<b>Jurisdiction</b>	Tax lots	Aerial Photos	Vacant Land	Developed Land	Land Use	Zoning	Comp Plans	Streets	Parks
Metro	D/U	D/U	D/M/U	D/M/U	U	D/U	D/U	D/M/U	D/M/U
Clackamas County	M/U	U	U	U	D/M/U	M/U	M/U	M/U	U
Multnomah County	M/U	U	U	U	D/M/U	M/U	M/U	U	U
Washington County	M/U	U	U	U	D/M/U	M/U	M/U	U	U
Clark County, WA	D/M/U	U	U	U	D/M/U	M	M/U	D/M/U	U
Portland	M/U	U	U	U	U	M/U	M/U	M/U	U
Tri_Met	U	U	U	U	U	U	U	U	U
Beaverton	U	U	U	U	U	M/U	M/U	U	U
Hillsboro	U	U	U	U	U	M/U	M/U	U	U
Forest Grove	U	U	U	U	U	M/U	M/U	U	U
Tigard	U	U	U	U	U	M/U	M/U	U	U
Tualatin	U	U	U	U	U	M/U	M/U	U	U
Wilsonville	U	U	U	U	U	M/U	M/U	U	U
Lake Oswego	U	U	U	U	U	M/U	M/U	U	U
Oregon City	U	U	U	U	U	M/U	M/U	M/U	U
Milwaukie	U	U	U	U	U	M/U	M/U	U	U
Gresham	U	U	U	U	U	M/U	M/U	M/U	U
Port of Portland	U	U	U	U	U	U	U	U	U

**D** = Developer    **M** = Maintainer    **U** = User