MP01/47

A G E N D A

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METRO

Agenda

MEETING:	METRO COUNCIL/EXECUTIVE OFFICER INFORMAL MEETING
DATE:	April 24, 2001
DAY:	Tuesday
TIME:	2:00 PM
PLACE:	OCC VIP Room

CALL TO ORDER AND ROLL CALL

I.	**UPCOMING LEGISLATION**	
II.	**WHAT IS A STRATEGIC PLAN?**	Mounts
III.	**METROSCOPE**	Cotugno
IV.	**COUNCIL'S ROLE IN TRANSPORTATION POLICY**	
V.	**EXECUTIVE OFFICER COMMUNICATION**	
VI.	**COUNCILOR COMMUNICATIONS**	

ADJOURN

042401c-01

Introduction to Strategic Planning

Presented to: Metro Council
April 24, 2001

Tony Mounts, Financial Planning Manager, Metro

Topics

- What is Strategic Planning?
- Process
- Issues and Linkages

What is Strategic Planning?

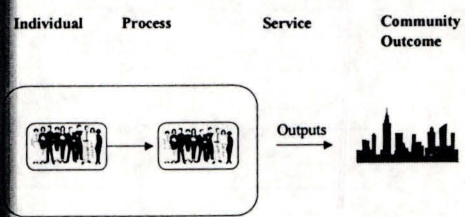
A disciplined effort to produce fundamental decisions and actions that shape and guide what an organization is, what it does, and why it does it.

John Bryson

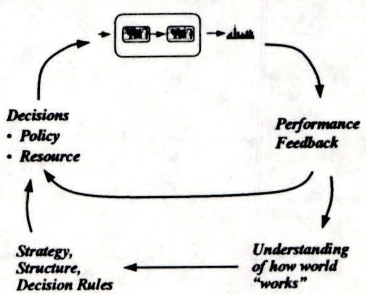
A Structured Learning Process

- Involves an organization's leaders
- Asks fundamental questions
  - Who and what are we, what do we do now, and why?
  - What do we want to be and do in the future, and why?
  - How do we get from here to there?
- Sets a course for the future
- Seeks positive, measurable change

Levels of Performance



Learning Cycle



Only One Element in a High Performing Organization

- Organizational Leadership
- Strategic Planning
- Customer Focus
- Information and Analysis
- Process Management
- Human Resources
- Performance Results

Malcolm Baldridge National Quality Award

The Strategic Approach

- Oriented toward the future
  - Anticipate rather than react to events
- Emphasizes relationship between external trends and internal capacity
- Focused on adaptive capacity
- Recognizes that uncertainty and complexity require "sense and response" capability
- Forces priorities and choices

Strategic Planning Process Steps

Steps

- Initiate and Agree on the Process
- Identify Mandates
- Clarify Mission and Values
- Environmental Assessment/SWOT
- Identify Strategic Issues
- Formulate Strategies
- Review and Adopt Plan

Step 1: Initiate and Agree on the Process

- Purpose of the effort
- Structure
  - Planning Committee
  - Project team
- Timeline
- Process steps
- Commitment to proceed

Purpose of the Effort

- Focus
  - System, Community, Organization, Department, Program, etc.
  - Future in context of existing mission(s) and/or possible missions
- Results
  - Broad goals
  - Action plan
  - Improved communication
  - ???

Structure and Roles

- Process Sponsor
- Planning Group
  - Key decision makers
  - Major stakeholders
  - Horizontal and vertical representation
- Project Team
- Process Facilitator

Process Steps

- Who has to be involved directly and indirectly?
- How much information is needed?
- How much time and money are you willing to spend?

Reasons to Postpone

- Current or impending leadership change
- Immediate crisis
  - "The roof's caving in."

Step 2 - Identify Mandates

- What do we have to do?
  - Formally and informally
  - Sources
    - Charter, Laws
    - Expectations of key groups
- What do mandates require of us?
- What's left open?

Step 3 - Mission Statement:
A Declaration Of Purpose

- Who are we? What's our purpose? What business(es) are we in?
- What are the basic social and political needs we exist to address?
- What do we do to recognize, anticipate and respond to these needs?
- Who are our key stakeholders and how should we respond to them?

Mission (cont.)

- What are our philosophy, values, and culture?
- What makes us distinctive or unique?
  - Core competencies

Step 4 - Environmental Scan

- Review external trends to identify Opportunities and Threats
  - Future oriented
- Take stock of the organization to identify Strengths and Weaknesses
  - Present oriented
- A holistic view of the organization and its operating environment

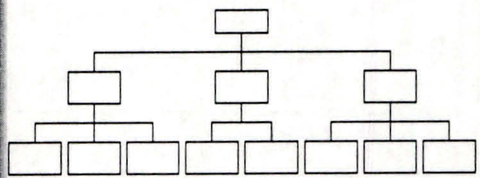
Opportunities and Threats

- Forces and Trends
  - Political, Economic, Social, Technological
- Key Resource Controllers
  - Customers, Clients, Taxpayers, Regulators
- Collaborators/Competitors
  - Public, Private agencies/organizations

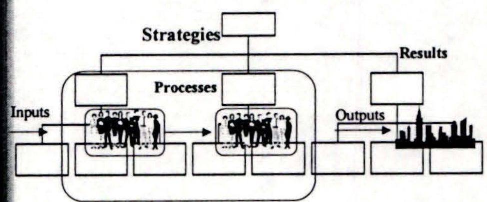
Strengths and Weaknesses

- Assess
  - Inputs
    - ➪Financial, Human Resources, Information, Facilities, Culture, Climate
  - Current Service/Program Strategies
  - Performance
- Take stock of the organization

Control View of Organization



Program or Process View



Service Portfolio

Direct Services

- Regional Parks
- Planning
  - Growth Mgmt
  - Transportation
- Solid Waste
- MERC
- Zoo

Support Services

- Governance/Leadership
  - Citizen Involvement
- Human Resources
- Information Technology
- Finance/Accounting
- General Counsel
- Public/Media Relations
- Creative Services
- Auditor

Information Sources

- External
  - 2040 surveys and studies
  - REM scan
  - Parks discussions
  - Wieden + Kennedy
  - Census
- Internal
  - Five-year Plans
  - Tower Talks
  - Employee Communication Survey

Step 5: Identify Strategic Issues

- The fundamental policy questions.
- They may affect:
  - Mission/Mandates
  - Service level/mix
  - Customers/clients/stakeholders
- They are most often Threats and/or Weaknesses

Three Type of Issues

- Issues that require immediate response
- Issues that can be handled within normal planning processes
- Issues that require no action now, but should be monitored

Examples of Strategic Issues

- Growth Management
  - Reestablishing consensus on 2040 Plan
- Solid Waste
  - Achieving regional waste reduction targets
- Governance/Leadership
  - Transitioning to new leadership structure for Metro

Step 6: Formulate Strategies

- Creative, freewheeling stage
  - address issue
  - link to the environment
- Levels
  - Grand, organization or multi-organization
  - Sub-unit (department, division, etc.)
  - Program, service, business process
  - Support (Finance, HR, Facilities, IT)
- Establish performance expectations
  - Measures

Strategy Evaluation

- Acceptable to key decision makers and stakeholders
- Customer or citizen impact
- Relevance to issue
- Consistency with mission, values
- Coordination with other strategies
- Technical feasibility
- Cost

Step 8: Review and Adopt Plan

- Produce Plan
  - Audience
  - Level of production and detail
- Review, discussion, modification, adoption
- Dynamics depend on arena for review

Post Adoption

- Plan Implementation
  - Assignments
  - Monitoring
- Ongoing planning process

Links and Issues

Linking the Strategic Plan to the Budget

- Basis for resource requests
- Communicate issues and strategies within public process and document
- With performance-based budget, link strategies to program resources and measurable results

Issues

- Timing
  - Structure & Leadership change
- Current strategy processes
  - 2040
  - Parks & Greenspaces
  - REM
  - MERC
  - Transition
  - Budget Notes - Support Services

Possible Next Steps

- Review Council role in current strategy processes
- Use budget notes to define approach to support services
- Sub-group to work on strategic plan proposal

Discussion Questions

- **Is there interest in a strategic planning process?**
  - **If so, when?**
  - **Focus?**
- **What objectives should drive the process?**
- **Should a group work on a more detailed proposal?**
  - **If so, who?**

042401c-02

Metro Periodic Review

DRAFT

Metro UGB Analysis and Policy Development Diagram

(Goal 2, 9, 14 Analysis)

Council Policy Choices
1. Expand UGB
2. Change Regulations
   - Focus capacity in 2040 centers
   - Provide employment land in centers/ other areas
   - Analyze subregional issues for jobs/housing
   - Change zoning and design types
   - Change RTP focus
3. Develop Economic Incentives

Public Involvement
- Regional Growth Conference
- Table talks, stakeholders
- Open Houses
- Local Government Coordination
- Council Hearings

Potential Council Decisions:
Council Actions (Fall 2002)
- UGB Amendments
- Develop new policy to change Land Use patterns to increase capacity in UGB
- Combo UGB amendments and Land Use Policy
- Transportation / RTP changes

Council evaluation of research data may prompt Council to amend the Regional Framework Plan.

Goal 14 Analysis

Other Planning Studies
- 2040 Centers
- Employment Study
- Goal 9 coordination

Assessment of 20 Year Land Need
"UGR analysis"

Alternatives Analysis
- Identify & Analyze Exception Land surrounding UGB
- Assess impacts to natural resources, agriculture, public facilities
- Remove some exception land from further study based on ORS 197.298

Data Assumptions
1. Regional Population & Employment Forecast
2. Buildable Vacant Land Analysis – 2000
3. Redevelopment & Infill Study Information
4. Regional Transportation Plan
5. Current Land Use Goals, Policies & Regulations

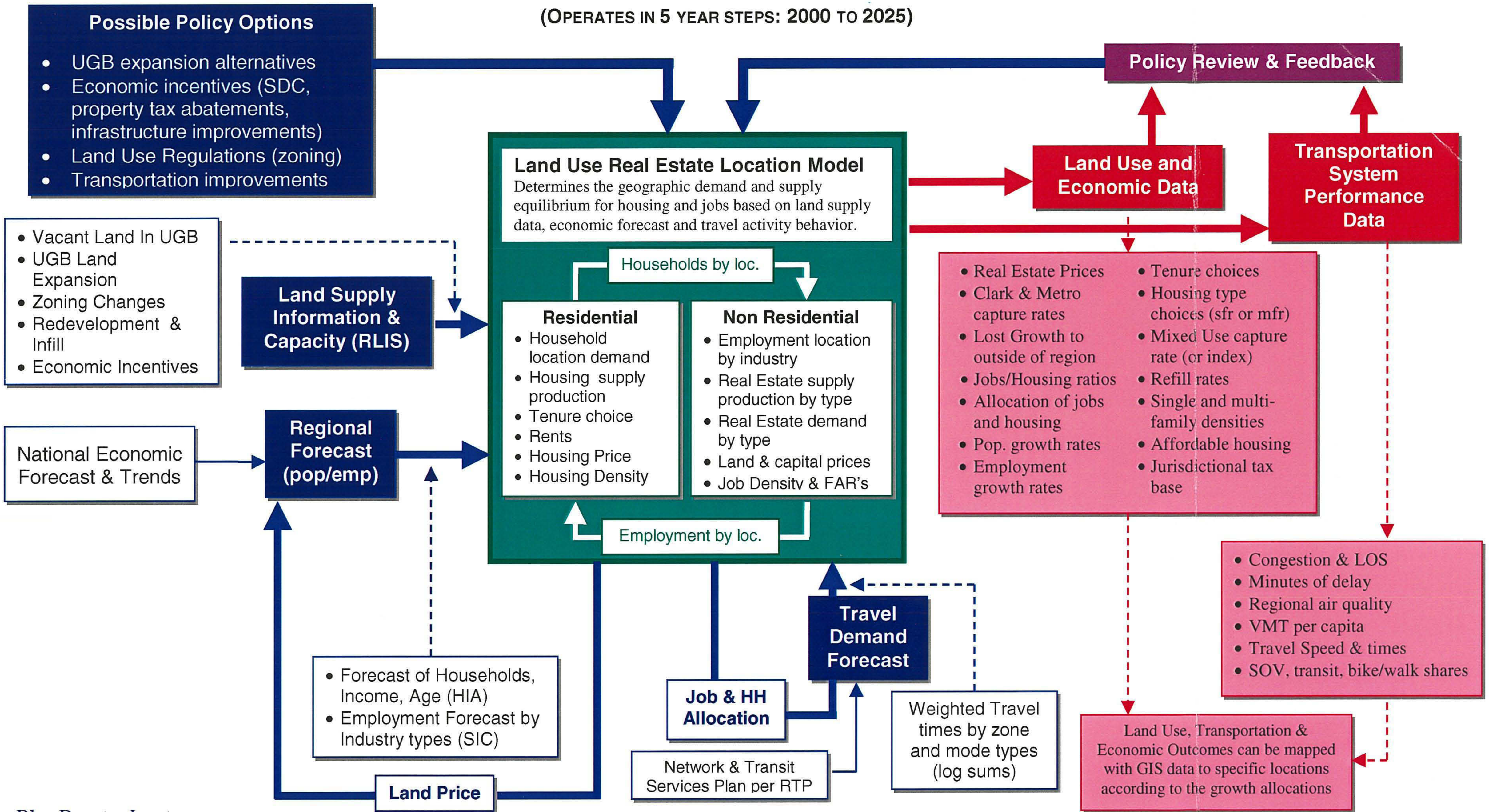
MetroScope
Policy Evaluation Tool
1. Case Study Research
2. Analysis of Preferred Alternative formulated by Council

Council Analysis of Case Study Research Agenda
- Review MetroScope Case Studies
- Assess the Costs & Benefits in each Case Study
- Evaluate tradeoffs of each Case Study with respect to the Policy assumptions
- ***Develop Preferred Alternative***

perrevflow
March 14, 2001

METROSCOPE MODEL SCHEMATIC

(OPERATES IN 5 YEAR STEPS: 2000 TO 2025)



Blue Denotes Inputs
Red Denotes Outputs
(circular flows indicate policy feedbacks and model iterations)

January 26, 2001

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Periodic Review
WP

M E M O R A N D U M

METRO

March 12, 2001

To: Rod Park, Chair
Community Development Committee

From: Lydia Neill, Senior Regional Planner LN
Planning Department

Regarding: Periodic Review and the MetroScope Research Agenda

This memorandum provides an overview of the policy analysis element of the Periodic Review work program and a discussion of the value and use of a newly developed research tool called MetroScope. The memorandum is divided into six sections:

- Overview of the technical products in the Periodic Review work program;
- Explanation of how MetroScope may be used to examine policy options;
- Recommended MetroScope outputs;
- Recommended standard assumptions;
- Description of case studies and assumptions, and
- Next steps

Periodic Review

Accommodating the need for jobs and housing in the region according to the requirements in ORS 197.296 involves a combination of increasing densities inside the UGB and/or expansion of the Urban Growth Boundary (UGB). Periodic Review of the UGB provides the framework in which the research, analysis and policy choices are presented to policy makers and the public.

The Periodic Review work program includes these technical and policies elements:

- 2000-2025 Regional Population and Employment Forecast
- 2000 Buildable Land Supply
- Alternatives Analysis (analysis of potential new urbanizable land)
- Examination of Additional Capacity Inside the Existing UGB
- 2040 Centers Analysis - Research on What Makes Centers Work
- Policy Discussion and Research on Employment Land Supply
- Policy and Technical Examination of Complete Communities/Subregional Analysis
- Evaluation of Alternative Development Patterns Using MetroScope to Test 2040 Refinement Policies

- Reconciliation of Land Supply and Demand According to Policy Direction from the Metro Council

Using the MetroScope Model to Examine Policy Options
Use of MetroScope for the analysis of policy objectives is an integral part of Metro's Periodic Review of the Urban Growth Boundary (UGB) work program. MetroScope is an interactive model that uses the regional forecast, a GIS database and the transportation model to forecast where jobs and housing will locate and to quantify the associated impacts on land consumption, land price, travel patterns and transportation system performance. Staff has identified several case studies that typify a range of policy choices associated with the refinement of the 2040 growth management strategies.

<u>Research Agenda</u>
MetroScope is one tool available for decision-makers to evaluate policy options before enacting new regulations. Other tools might include the Urban Growth Report or individual studies that evaluate employment or performance in mixed-use centers. MetroScope can be used by policy makers to test different policies to determine the benefits and weigh them against any social or economic costs associated with enacting these policies. Decision-makers can use MetroScope to gauge how to refine policies to meet objectives currently established in the 2040 growth concept or to meet new goals or objectives for the region.

The focus of the research agenda will be to use MetroScope to improve our understanding of how existing 2040 policies impact employment and housing demand, estimate how demand for future buildable land might be impacted given different policy assumptions, and the close interaction that exists between land use and the transportation system.

Additionally, we will use MetroScope's modeling of regional behavior to examine the relationships between subareas and regional performance for transportation, tax base, access to employment and the performance of 2040 centers. The Periodic Review work program's research agenda is aimed at gleaning information that will be useful to the Metro Council in refining new policy options for the region and eventually developing a preferred alternative for accommodating anticipated future population and employment need.

<u>Timing</u>
The Periodic Review research agenda is designed to provide information to policy makers to assist them in developing new policies and refinements to the 2040 Growth Concept to meet future need through the period 2002 to 2022. MetroScope will be used in two phases to bring this information forward to the Metro Council for their decision at the conclusion of Periodic Review in the fall of 2002. Phase 1 is intended to be a research study phase to explore how a broad range of policy options affect regional growth, land use and transportation choices and is scheduled to be completed in mid-summer 2001.

Phase 2 begins after the Metro Council has analyzed the results from Phase 1 and begins to narrow down policy options to develop a preferred set of policies or alternatives. This final policy study or preferred set of alternatives represents the Metro Council's decision on how this region plans to accommodate the anticipated future needs of this region during the 2002 to 2022 time period.

Model Review and Documentation
MetroScope is currently undergoing a local and national peer review. This review should conclude by fall 2001. Metro is contracting with a local consultant to produce a written narrative of how the model operates. This document as well as model outputs from case studies will be reviewed by the local peer review group in March 2001. A national review panel will convene during the summer of 2001.

Phase 1 - Research Policy Issues
MetroScope is an interactive tool that requires direction and assumptions from policy makers to function. The MetroScope simulation model uses input from the regional forecast, the RLIS database and the transportation model to forecast where growth will locate and the associated impacts on land supply consumption, land price, travel patterns and transportation system performance. Staff has identified several case studies that explore a range of policy choices associated with refinement of the 2040 growth management strategies. The basic policy issues represented in the case studies are:

- Examination of incentive policies, UGB expansions and transportation improvement to support the development of 2040 centers
- Examination of expansion of the UGB to address a need for jobs in Clackamas County
- Examination of the affect of transportation improvements to improve the Columbia River crossing on land uses (I-5 Trade Corridor Study)
- Examination of the affects of achieving a subregional job/housing balance
- Accommodating all of the estimated 2022 growth in the existing UGB
- Examination of the affects of developing a new community in the Damascus area

Comparison of Case Studies to 2040 Values
Staff recommends exploring the performance of specific policy objectives in the test cases by comparing the model results against the policy objectives of the 2040 Growth Concept. The primary 2040 policy objectives are:

- Encourage the efficient use of land within the urban growth boundary
- Focus growth in 2040 mixed use centers and corridors
- Protect the natural environment
- Provide a balanced transportation system by promoting all types of travel such as bicycling, walking and using mass transit, as well as cars and facilitating freight movement
- Promote diverse housing options for all residents of the region
- Encourage a vibrant place to live
- Encourage a strong regional economy

The results will also be compared against the performance indicators of the 2040 base case and the factors in the1997-2017 Urban Growth Report (October 2000 Update) (UGR Update).

Evaluation of MetroScope Outputs to 2040 Growth Concept Performance Criteria
What follows is a list of general questions that can be used as a basis for testing concepts in each of the succeeding case studies. All of the following questions relate back to whether the desired 2040 outcomes are being achieved.

- How effective are the current and "test" policies in achieving 2040 goals and objectives?
- Do the policies support and encourage mixed-use development in the 2040 centers?
- What are the economic & social tradeoffs?
- How do the policy changes affect population and employment distribution?
- How does policy impact local tax base/revenues?
- How efficiently is land being used inside of the UGB?
- Does the analysis case improve or maintain accessibility to activities throughout the region?
- Are travel times and distances increasing or decreasing in key areas identified around the region?
- How do the policies affect non-work trips?
- What effect do the policies have on travel / commutes outside the UGB?
- In what way is air quality affected, and water quality?
- Are real estate prices increasing at a greater rate than the trended prediction?
- How much growth goes to other areas such as Clark County or neighboring cities outside of the metro area or even Salem?
- What portion of growth is going into mixed-use centers?
- How much of the growth can be accommodated through refill?

Establishing Standard Assumptions for All Case Studies

Staff recommends that each case study begin with a common set of assumptions. These common assumptions provide act as a control so case study results can be properly evaluated. Listed below are the standard assumptions.

Common Assumption in Every Case Study

- 1997 UGR Report Update (October 2000) assumptions as initial starting values for capture rate and refill rate
- 2000 Employment Geocode
- 2000 Buildable Lands Analysis (MetroScope Land Database)
- Refill stock identified in the 1997-2017 UGR updated to year 2000 for both residential non-residential
- 2000-2025 Regional Forecast control totals for 4-County area
- Modified Clark County data normalized to Metro standard designations (e.g. zoning, vacant land definitions, etc.)
- Urban Growth Management Area zoning assumption in Clark county for new urbanizable areas
- Assume a five-year lag before services are available to new urbanizable areas
- Priority RTP
- Existing zoning provided by local jurisdictions as of January 2001

- All Rural Residential/ Future Urban (RRFU) zoning for land located inside of the UGB will be upzoned to a Standard Regional Zone of Single Family Residential (SFR-3, 5,000 to 7,000 square foot lots)

Recommended Test Cases

Case A: Base Case – Application of Current 2040 Policies

Case A, the 2040 Base Case, represents recent changes in local land use policies to reflect Metro's requirements in the Functional Plan. In a strict sense this case study applies state law and uses the regulations that the region currently has in effect. The 2040 Base Case utilizes updated zoning information provided by local jurisdictions that was adopted in response to Metro Functional Plan requirements (Title 1). The 2020 RTP is used in this analysis to provide a more up to date transportation network system and assumes the same funding priorities that reflect existing 2040 policies. A new 2000-2025 population and employment forecast gives a more current picture of demand and the new 2000 land supply data updates the information on the supply of vacant land. A stock of redevelopment and infill is identified in the model base run. The Base Case is studied in this analysis to better understand whether or not the existing 2040 policies are sufficient to bring about the anticipated change in the 2040 centers and improve the efficiency in how land is used.

The Base Case is valuable because it will be used as a "benchmark" to compare the effectiveness of policies to achieve the 2040 objectives.

What we hope to learn

How 2040 policies according to State land use law (ORS 197.296) change the use of land over time. Are the amounts and location of land additions efficient and do they support 2040 policies? Is it efficient to only add land incrementally at the edge of the UGB on exception land? Do current policies result in efficient use of existing land within the UGB? Does this approach support and enhance 2040 center development?

Case B: I-5 Trade Corridor Study

This case study examines the transportation and land use effects of adding highway and LRT capacity across the Columbia River in the I-5 corridor. This case study will use the status quo land use policies and a 20-year supply of land obtained from Case A (Base Case). All other transportation aspects will be the same as Case A. A second iteration will test the affects of policy changes to current land use regulations and development incentives for both inside of the UGB and Clark County without adding any capacity improvements to this corridor.

What we hope to learn

Do major transportation improvements to the I-5 corridor diminish or enhance the effectiveness and the implementation of the 2040 growth concept and what policy changes could potentially support both the Clark County and Metro area plans? What are the dynamic land use and transportation effects – especially in Clark County?

Additional Case Studies

<u>Case C: Enhanced 2040 Centers</u>
A key component to realizing the 2040 urban form is the development of the 2040 centers. This case study will explore how much additional employment and population growth can be accommodated in 2040 centers through economic incentives, targeted transportation investments and other policy changes. The focus of this case study is to examine what amount and type of public intervention (subsidy) is necessary to redirect the market to the 2040 centers. Expansion of the UGB will only be considered if it facilitates the development of a center. Expansion would be limited to exception lands.

<u>What we hope to learn</u>
What additional policies and incentives will enhance the functionality of 2040 centers? How much does it cost to implement these possible measures? What type or mix of jobs can be achieved in the 2040 centers—are we successful in attracting jobs?

<u>Case D: Hold the UGB</u>
This case study examines the implications and opportunities associated with accommodating the 2002-2022 forecast population and employment growth for inside the existing UGB. The staff at the Department of Land Conservation and Development assisting Metro with Periodic Review has asked that this case study be added to the work program.

<u>What we hope to learn</u>
What are the implications, opportunities and drawbacks of accommodating all the 2022 estimated growth inside the existing UGB? What happens to housing prices, capture rates, and congestion, etc.? For example, do we achieve the 28% refill rate (UGR Update) in this case study?

<u>Case E: New Community in Damascus</u>
The New Community case study would answer questions about whether creating a full service community in Clackamas County to address the need for jobs is an effective policy option that does not conflict or compete with current 2040 policies. Clackamas County has identified a need for more jobs in the County. The County has identified specific industries it would like to add to its employment base. Based on the land characteristic needs of these industries, providing land for these jobs will mean bringing more land (perhaps more than a 20 year supply) into the UGB to include these employment lands. This case would simulate the full impact of focusing growth in <u>one</u> (Damascus) subarea of the region. The policy implications for this case study focus on whether or not public policy and public investment can effectively redirect the location decisions of specific industries. The implementation of the policies articulated in this case study may require changes to Metro Code and State law.

<u>What we hope to learn</u>
Does developing a new complete community in the Damascus area more effectively accommodate a 20-year need for land? Does this approach support development of the 2040 growth concept for areas inside the current UGB? What is the transportation infrastructure needs necessary to create the accessibility to make a community function properly? How does this case study impact jobs-housing balance?

Employment Study

Metroscope

Case F: Subregional Jobs/Housing Balance
The Jobs/Housing case study examines the effects of adding lands outside of the UGB or converting land inside the UGB to balance jobs and housing within subregions or market areas. Six subareas have been identified and they include central Portland east, west, southeast, southwest and Clark County. (Metro Council may wish to discuss and redefine these initial subareas.) The market areas are drawn to be approximately the same size and are based on travel times from an identified center. This case study tests the question of whether a balance of jobs and housing at the subregional level more efficiently allocates the land supply and maximizes the efficiency of the transportation system than Metro's existing regional approach. The boundaries of the subareas were derived from work completed for the RTP. The implementation of the policies articulated in this case study may require changes to Metro Code and State law.

What we hope to learn
Evaluate the effects of adding or converting land for employment or housing in subareas that have been identified as having disproportionate high amounts of either jobs or housing. How does this case support 2040 center development? Does this moderate the problems associated with congestion and continue the latent demand to build more regional roads and freeways? Is this method of allocating growth more efficient than the current means Metro allocates regional and expands to accommodate this growth?

Case G: Market Expansion – UGB expansion to fulfill market demand
2040 policies reflect the region's values and attempt to change market demand and actions. The Market Expansion case is a simulation of market activity without the benefit of State law and Metro Code that attempts to encourage efficient use of land and prohibits urban expansion onto resource lands. This case study can serve as a comparison (or contrast) on how much land and where the region might grow if the market were the deciding factor. This simulation is critical to balancing our understanding of how regional policies affect regional growth, land use and transportation choices. This case study informs us on how the market behaves unconstrained by land use goals and is a basis for indicating which public policies could be used to re-direct or bend market trends.

What we hope to learn
Where will growth locate (both inside and outside of the UGB) if land was to freely develop according to real estate demand? What are the regional costs? How much land is really consumed in this market test case? What are the consequences of this case as it relates to the 2040 base case and 2040 objectives? How are capture rate, refill rate, accessibility and the success of 2040 center development differ from the base case? Does this case worsen the perceived imbalance in tax-base revenues?

Next Steps

The case study analysis element of the Periodic Review work program is due to be concluded by summer 2001. It is likely that it will not be finished until the late summer or early fall. The case study review process is designed to evaluate the benefits and trade-offs of various policy choices to accommodate the region's 20-year forecasted need for both jobs and housing. This policy tradeoff discussion and the 2040 performance measures will be the focus of the regional growth conference in February or March 2002. When the public outreach is concluded in late spring, Metro Council will provide staff direction on the preparation of the preferred policies and methods to accommodating growth. Another round of public outreach will commence in mid- to late- summer with public hearings before the Metro Council in the fall 2002.

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DRAFT

METRO

MetroScope Inputs & Assumptions

MetroScope is a policy analysis and simulation/measurement tool. It gives policy makers an opportunity to visualize how policies today could re-shape the urban landscape of the future. It provides a systematic means of relating transportation infrastructure decisions and the regional economy to the way people and businesses react to public policies. The advantages of this integration is the complete specification of how forecasted population and employment is distributed across the region given existing and projected land use regulations, travel demand parameters, and public policy incentives.

This memorandum specifies the main policy input information necessary for MetroScope model runs of the Base Case and I-5 Transportation Corridor Study (Case Study: A & B). These assumptions and some changes may also be used to formulate other case study options. This memorandum outlines the policy assumptions and background information for policy makers to evaluate and give policy direction.

Additional case studies are proposed. These case studies represents a spectrum of issues raised by the region on how to manage regional growth. The case studies offer alternative urban forms which emphasize a different subregional approach to accommodating total regional growth.

Primary MetroScope inputs are discussed in this memorandum. In order to simulate or quantify how MetroScope allocates forecasted regional growth, we need policy direction from the Metro Council on what basic data should be assumed for the Base Case Study. This memorandum lists a series of staff recommendations documenting the assumptions for phase 1 of the MetroScope research.

MetroScope Operations – A Quick Overview of the Major Components.

MetroScope requires data from different sources. In reality MetroScope is four models combined together into one. The newest component is the residential and nonresidential real estate location models. It is the perspective of the location model component that we describe the data inputs (see: MetroScope Model Schematic for an illustration).

The development pattern or urban form for this region is in part described by the following data inputs into the residential and nonresidential real estate allocation components:

1. Regional Economic Forecast (land demand)
2. Vacant land, redevelopment and infill, environmental overlay information (land supply - RLIS)
3. Travel Behavior and Demand (travel times)
4. Public Policy (UGB amendments or regulations)

The Regional Forecast estimates how much employment and population growth is to be expected during the 20 year study period. The increase in population and employment is representative of the amount of additional activity the region is anticipated to have. This activity takes the form of additional travel, need for more housing, and land to accommodate future employment expansion. The Regional Forecast drives the projection of land demand for future years.

On the supply side, vacant land, redevelopment and infill are tabulated from RLIS and MetroScope data pre-processors. These data sources represent the supply or inventory of land on hand to accommodate the forecasted 20 year need and are the second set of input data needed to run MetroScope case studies.

Travel demand data, in the form of logsums, are used to help allocate future household and employment growth into census tracts and employment zones. Travel times derived from the logsums reveal information about how people are able to get to work, recreate and shop from one zone to all other zones. The logsums are one set of attractiveness factors used in locating which zone employment and housing may choose to locate.

The residential and nonresidential location models operate in tandem by interfacing each other by exchanging employment location information from the nonresidential component to the residential component. In turn, the residential location component provides labor force and housing location data to the nonresidential location component. This interface attempts to optimize household preferences for a range of locational (i.e. neighborhood) amenities with households desires to minimize distances to work, shop and recreate subject to household income constraints. (In other words you can't buy more housing and amenities that accompany the choice of housing location than the household can afford.) Perturbations in housing prices allows the model to change housing demand and supply configurations to drive each zone into an equilibrium. Changes in prices alter the thresholds for housing redevelopment and infill opportunities. This process of optimization of each type of household (arrayed by household size, income and age distributions) with attributes of the land supply in each zone and the proximity of labor to employment opportunities (location) determines housing location and choices.

The housing choice model identifies up to 6 housing choice options from each of 441 HIA categories. These choices break down to 2 tenure choice (own or rent) and 3 building type (single family attached, single family detached or multi-family) preferences. The choice of building types projected by MetroScope take 15 industry employment classifications and allocates building space demand to 6 types (general industrial, tech-flex, warehousing, office, retail, medical, and government/institutional buildings).

The nonresidential location component attempts to locate the labor force implied by the workers in households in the region. The regional job forecast provides the amount of employment growth and the demand of firms for labor in the region. Firm location and employment are determined by three main factors: proximity or location to jobs of similar types (cluster), proximity to all other jobs (agglomeration), and proximity to households. Perturbations in employment land prices allows the model to seek an equilibrium between the demand and supply for employment space. These price changes may also affect redevelopment and infill propensities for employment. Densities (floor to area ratios – FARs and square foot per employee – SFEs) also may vary as prices for buildable land and the rent price on building space move up and down in each employment zone. The optimization of these demand factors with land supply attributes determines employment location.

These employment and housing choices do not remain static. Employment and housing choice can change as economic, transportation and land use conditions vary in the future.

BASE CASE STUDY – INPUT ASSUMPTIONS

Regional Forecast.

The regional forecast of employment by industry, population and households by age is the basis for determining need (housing and employment demand) as was for the Urban Growth Report (UGR). MetroScope uses these same inputs. The model uses the regional forecast to calculate the need basis while also combining feedbacks from transportation and land use. Instead of calculating this need in regional aggregate terms, MetroScope provides a more detailed analysis of where, when, what, and how much the need could be for different housing types and employment by industry.

The regional forecast has been peer reviewed by a panel of business economist, staff from the state economist office, Port of Portland, electric utility analysts, economic consultants to industrial firms in the region, land use planners, and demographers. MTAC, MPAC and the former Growth Management Committee.

Additional releases of 2000 Census data will soon be available. Metro staff intends to re-calibrate the forecast using an actual 2000 population number instead of estimated population counts. This will provide a more accurate forecast of demand.

Staff Recommendation:

- **For Phase 1, MetroScope Case Studies, use the same regional forecast for the 4-county area in each 5 year increment and in each case study under consideration to ensure comparability across all studies.**
- **Re-calibrate the forecast using the actual 2000 census population number. Adopt this Census-adjusted regional forecast for analysis in Phase 2.**
- **Select the case study with the greatest land price increases to evaluate the impact on the regional forecast.**

Urban Growth Report Demand Factors.

The urban growth report demand factors are not input assumptions. Instead they are modeling outcomes or indicators that are to be monitored in each case study. In each 5 year model increment, fluctuations in these rates may indicate additional policy actions/assumptions. Policy action (amending UGB, incentives, or regulations) may be required in each 5 year increment to promote the case study test objectives, such as maintaining stable land prices, emphasis on redevelopment and infill and/or economic development in a subregion or centers.

The Metro Council made policy decisions in the *1997-2017 Land Need Report* (UGR) on the following urban growth demand factors:

1. employment capture rate - 82%

2. housing capture rate - 70%
3. residential refill rate -28.5%
4. non-residential refill rate - 21% (industrial) and 52% (commercial)

These demand factors were based in part on historical data from the last 5 and 20 years. When Metro finalized its *1997-2017 Land Need Report*, we lacked the technical ability to dynamically project future refill or capture rates. With MetroScope, we now have the means to simulate and forecast future rates of these performance indicators. Depending upon policy inputs and assumptions, each case study may lead to a different set of capture, redevelopment and infill rates as possible outcomes. In addition, other measures of economic output, transportation and social variables will change accordingly with different inputs and assumptions. Evaluation of each case study and corresponding tradeoffs will provide a basis to determine a preferred alternative that could be the starting point for a new UGR (2002-2022) need determination. The Metro Council may choose to tradeoff projections of these rates in consideration against other transportation, economic and/or societal considerations. A preferred alternative (policy inputs determined by the Metro Council) derived using MetroScope may provide the necessary supportive findings for a Final UGB Decision. For Phase 1, the proposed case studies test the impact of a wide range of identified policy issues.

Staff Recommendation:

- **Begin each model run (year 2000) with a <u>supply</u> of redevelopment and infill land equivalent to the rate of redevelopment and infill assumed in the 1997-2017 Land Need Report – for housing and employment.**
- **In the Base Case, the capture rates and redevelopment and infill rates should mimic, to the extent possible, the assumptions contained in the 1997-2017 Land Need Report. These rates may fluctuate in each 5 year interval, therefore attempt to maintain the capture rates within a tolerance range of historical experience. In succeeding years, base each 5 year UGB need on the historical capture rate averaging in the new 5 year forecast just completed. The redevelopment and infill rate may freely change as economic forces dictate within the model run assuming the re-fill supply is replenished with new land values to building value data from the model.**
- **Metro Council may consider using the data gleaned from each case study to evaluate and determine a preferred set of policy assumptions that may produce projected rates of redevelopment, infill and capture that balances regional values and goals for economic growth, preservation of natural resources, transportation services, and infrastructure development and costs.**

Transportation Data.

The Metro travel forecasting models are now interactively linked to the Residential and Non-residential Real Estate Location components of the MetroScope model. For the first-time, land use allocations are dynamic. In other words, employment and housing locations are free to change in each 5-year increment subject to interaction and feedback with travel demand parameters (logsums). This produces a more robust forecast which properly incorporates the impact that land use has on transportation and vice-a-versa.

Staff Recommendation:

Use the following travel forecasting assumptions:

- **Priority (i.e., Strategic) Regional Transportation Plan (RTP) that describes when, where and what kinds of road, bridge, and transit improvements for the future**
- **Assume travel time statistics as given by the travel forecasting model to define accessibility of each zone to other zones (i.e. logsums derived for each travel analysis zone and "skimmed" [aggregated] to census tracts and employment zones) for each 5-year increment.**

Environmental Resource Protection Options.
The Department of Land Conservation & Development (DLCD) during Task 1 of Periodic Review directed Metro to presume a level of resource protection based on the adopted Title 3, water quality protection regulations for the *1997-2017 Land Need Report*. Until a habitat protection program is defined and adopted, Metro may only deduct from the buildable land supply those areas that are protected by adopted regulations. When the Council has defined the preferred policy direction and the habitat protection program and an adoption date is imminent, only then can a 2002-2022 land need determination consider a broader scope of environmental protection.

In the 1997 UGR, upland steep slopes were excluded from buildable land. Subsequently, upland steep slopes were included into the UGR estimate of buildable land (except where protected by Title 3). Upland steep slopes are generally sensitive habitat lands and are more difficult to develop and pose potential environmental and public safety hazards. However, Metro does not presently have regulation in place that limit local government's ability to permit development in these areas.

Staff Recommendation:

- **Assume Title 3 protection on all lands (inside and outside the UGB) considered in the case study runs,**
- **Use Title 3 to define and exclude "unbuildable" land,**
- **Include upland steep slopes (i.e., sloped areas outside of Title 3) as part of a calculating the available development capacity for the case studies and provide direction to staff through the Goal 5 program for the preferred policy direction.**

Vacant Land & Buildable Land Analysis.
The DRC has developed a detailed tabulation process for estimating the amount of vacant land in the region. This methodology has been consistently used for identifying vacant land since 1994. Using very accurate aerial photography, assessor information, and building permits, staff visually inspects every tax lot in the region to determine whether the lot is entirely vacant, partially vacant, or wholly developed. Staff has consistently defined vacant land parcels to a level of precision of ½ acre.

First, using aerial photography, vacant land is visually identified on a tax lot basis. This process identifies any whole or partial tax lots that have no visible development or structure. Assessor information may be used to confirm this identification when visual inspection is inconclusive. Any part of a tax lot with a contiguous vacant area larger than ½ an acre per tax lot gets selected as part of the vacant land inventory. Partially vacant tax lots are identified in this manner.

Land and improvement values (county tax assessor) are not used in the identification of partially vacant lots. The current method of identifying vacant land accurately reflects whether the lot or a portion of the lot has any standing structure on it. Efforts to determine if a partially vacant tax lot has any capacity for future development are computed during the buildable lands analysis step.

Buildable lands are defined as Gross Vacant Land less Title 3 land. The difference is noted as Gross Vacant Buildable Acres (GVBA). Our current buildable lands analysis method does not consider expensive homes (located on the half of a lot that has been identified as the part developed) a long term limitation to partially vacant lots developing in the future.

Staff Recommendation:
- **Use the recently completed 2000 Vacant Land Analysis**
- **Continue to define GVBA = Gross Vacant Acres minus Title 3**

Supply of Redevelopment and Infill.
In prior assessments of the UGR need, the amount or stock of redevelopment and infill ("refill") land was not estimated on a site-specific basis but was assumed to be available to meet historic rates of refill development. MetroScope requires a more precise method of accounting for the location and amount (supply) of potential refill land. In this approach, growth is allocated to land identified as redevelopment or infill in a manner similar to vacant buildable supply.

After the land base has been identified and divided into the vacant or developed category, candidate redevelopment and infill lots are identified from the existing developed parcels (also includes the part of tax lots that have been noted as partially developed). Developed parcels are run through a "screen" to identify whether it is (or not) a candidate for redevelopment or infill. A MetroScope Refill pre-processor database function sorts and ranks the developed land according to its likelihood for redevelopment or infill. This selection of candidate refill sites is based on zoning data, lot size, building value, and land value. Land values can change over time, so the inventory of redevelopment and infill also changes as building values and land value changes in each 5 year model run period. Smaller parcels tend to redevelop sooner than larger parcels. These candidate refill parcels represent the universe of potential refill stock. Not all of these candidates get "refilled" during the course of each 5 year increment. A subset (reference is to Land Filter) of these candidates must be identified by an expert panel and then included into the entire stock of eligible developable land (i.e., vacant land + candidate refill stock). Future need gets allocated to the eligible stock of developable land; however, not all of this land is consumed in each 5 year period – what remains should still be about a 15 year supply.
After completing the vacant land study, staff then determines the gross amount of buildable (GVBA – gross vacant buildable acres) land in the UGB. This estimate is then used in the UGR to estimate capacity.

An expert panel is necessary to "simulate" the workings of the land supply market. The land supply market has two major market participants: asset managers and builders. We consider "asset managers" as individuals who buy and sell land as an asset in a larger portfolio. They can hold land indefinitely because they are capable of perceiving a stream of benefits from holding land by itself as an asset. Builders on the other hand can only derive a stream of benefits from the purchase, development and later sale of the land and its improvement to households or employers. This is a simplification of how the land markets really work, but this minimal description of the land market behavior is necessary to balance demand for housing and jobs with how the land supply is metered out into what's available and not available.

An expert panel should be comprised of:
1. Metro area Real Estate professional (one)
2. Clark county Real Estate professional (one)
3. Metro Area Regional Planner (one)
4. Clark county Regional Planner (one)
5. Metro land use economist (one)
6. Regional Business Economist (one)

Staff Recommendation:
- **Employ methodology described for MetroScope for the identification of candidate redevelopment and infill parcels. Comment on how to proceed with the expert panel and the land filter.**

Land Filter Assumption.
MetroScope requires a means of identifying the portion or quantity of land that may get consumed or developed during each 5-year interval. On the demand side, MetroScope forecasts the amount of vacant land needed for residential and nonresidential needs. A household forecast categorized into household size, income and age is the basis for projecting housing need by different zones throughout the region. Similarly, nonresidential land need categorized by 6 building types collapsed from 15 industry classifications is the basis for determining employment land need. These locational demand projections are calculated from parameters estimated in the MetroScope model.

However, the supply side for the regional land markets is not yet fully integrated. For the land market to find equilibrium, an expert panel or technical decision is required to allow the model to seek an equilibrium solution. The model must be given a supply of available vacant land (and redevelopment and infill supply) to which the projected demand can then have to choose from. What this means is that the Metro Council and/or an expert panel designated by the Council must simulate the decisions of land owners to offer or not offer up residential and non-residential land for development. The region may have up to a 20 year stock/inventory of vacant land for jobs and housing in any five year period, but not all the 20 year land supply is going to be on the market. RLIS and MetroScope land filters can identify which candidate lands are more likely to develop to satisfy near term residential demand, but MetroScope still needs some means of metering out the 20 year land supply in smaller units of time for development needs.

Staff Recommendation:
- **Convene an expert panel of economists and real estate professionals to work with Metro staff to consult on the workings of the land supply markets for the**

purpose of identifying land availability in each 5-year interval of the MetroScope case study runs.

- **The panel should be instructed to replicate a schedule of when and where zoning and public facilities will likely be delivered.**

Land Use Regulations.
The *1997-2017 Land Need Report* contained a memorandum that lists each jurisdiction and describes overall general compliance of local comprehensive plans with Functional Plan requirements. This demonstrates that in general each jurisdiction has complied with rezoning the city or county to be consistent with the capacity goals mandated in Table 1, Title 1. The Data Resource Center (DRC) routinely obtains local zoning data and incorporates this information into the Regional Land Information System (RLIS) database. There are over 400 local zoning categories, so the DRC categorizes each city and county local zone designation into a standardized regional zone (SRZ) classification. These SRZ mimic the actual zoning capacity of each city or county zoning type. The local zones have been updated as of local code revisions – January 2001.

There exists some vacant (undeveloped) land inside the UGB and in unincorporated urban Clackamas County that is still zoned RRFU (rural residential/future urban). Eventually this land is expected to develop into urban densities (e.g. – SFR 6, or lots 5,000 to 7,000 square feet).

Staff Recommendation:

- **Use the standardized regional zone (SRZ) classification as the means to compute residential and nonresidential capacity,**
- **Upzone land currently zoned RRFU to SFR 6.**

UGB Amendments.
Some case studies will assume an expansion of the UGB in each 5 year increment. The determination of when, where and how much will be largely determined by the policy directions given to staff by the Council and from the analysis of the output measures. The policy metrics, i.e. the policy themes being evaluated, are macro-regional indicators of land use, economic and transportation variables. They describe how the region is performing and is a means of steering a case study in the desired direction of the research objective.

Staff Recommendation:

- **Consider UGB expansions of no less than a minimum of 600 acres in any given location – this represents the lowest level of model accuracy**
- **Assume a 5-year lag before services are available in newly expanded areas**
- **Follow the policy directions identified by the Council regarding where to include land outlined for each case study**

Clark County Land Use & Capacity, Neighboring City Capacity & UGB's.
Land information describing current conditions in Clark County are not the same and inconsistent with Metro area data. DRC staff has normalized and standardized much of Clark County's land use information into a format identical to RLIS.

Future case studies may indicate continued consumption and allocation of future need in Clark county and neighboring cities. MetroScope has the capability of estimating residential growth inside the Metro UGB, Clark county and neighboring cities. At each 5 year growth increment, some land in these non-Metro areas may consume land. An assumption for how these areas may replenish their consumed land supply must be considered.

Staff Recommendation:

- **Employ best practices to combine the Clark County data with RLIS**
- **Clark County staff and Metro have jointly mapped potential expansion areas of Clark county's urban growth areas (UGA). Use these expansion areas to replenish the stock of vacant land for future need in Clark county. This amount should be based on the rate of consumption in the previous 5 years.**
- **For neighboring cities, assume the replenishment rate of vacant land in each 5 years equal to the rate of consumption estimated from the previous 5 years. Assume this is an expansion of the neighboring city UGB's.**
- **For areas outside UGBs, assume rural capacity remains unchanged and available. Supply gets reduced by the past 5 years of development in each 5 year increment.**

INPUT ASSUMPTIONS UNIQUE TO EACH CASE STUDY

In order to set the conditions for each case study, input assumptions from the base case are varied to test urban development patterns. Some of the input changes could include combinations of transportation infrastructure plans, supply/capacity and location of UGB expansion, or areas to emphasize redevelopment and infill. For each case study, policy makers are informed of what could happen to land and housing prices, congestion, regional growth, etc. given various set of assumptions. In any case, these alternate future simulations are determined by the conscious decisions of policy makers to change a set of policies and/or leave others as they are.

The list below summarizes a broad range of policy-driven case studies for policy makers to consider. Staff is recommending these case studies for the Phase 1, MetroScope, Periodic Review Work Program element. In Phase 1, there is a limited amount of time for preparing information before a process has begun for amending the UGB and/or policies. The case study research agenda attempts to maximize the broadest range of policy themes that have been raised by interest groups, stakeholders, MPAC/MTAC, and other city and county elected officials to the Metro Council.

CASE STUDY options A to G

Case A: Base Case – the base case study option analyzes the impacts to transportation (e.g., congestion), land use (e.g., growth allocation), and regional growth (e.g., housing and land prices) by exactly following State Law, state land use goals and Metro Code. Analysis of the base case should determine whether existing policies are supportive and sufficient in achieving the 2040 goals and objectives.

Case B: I-5 Trade Corridor Study – the I-5 trade corridor study examines the transportation and land use effects of adding additional highway and transit capacity across the Columbia River. Analysis of the I-5 corridor should determine the benefits/costs/trade-offs of different transportation improvements.

Case C: Enhanced 2040 Centers – this case study tests the possibility of further bolstering polycentric development in the region and is based on the notion that it is more efficient to focus employment and housing (mixed use) in centralized hubs scattered throughout the region. This case explores how much additional population and employment can be reasonably accommodated in designated urban centers. This examination includes an assessment of the amount of public intervention (e.g., subsidies, taxes, infrastructure, and other economic incentives) that may be needed to turn market forces in the direction of mixed use urban centers.

Case D: Hold the UGB – a case is made to explore the impacts of a no expansion of the current UGB. This was requested and included in this list of studies on behalf of DLCD staff. This case study examines the economic implications and opportunities associated with accommodating the 2002-2022 forecast of population and employment inside the existing UGB.

Case E: Damascus Community Development – this new community case study is expected to answer questions about whether creating a full-service community in Clackamas County is an effective and efficient urban form and does not conflict with current 2040 goals. This case explores the possible reality of accommodating the entire region's employment and population needs in this one subregion.

Case F: Subregional Jobs/Housing Balance – unlike previous case studies, the subregional jobs/housing balance case is solely based on the simple notion that if subregions within the larger whole are somehow numerically equilibrated, the deleterious effects of urbanization will vanish. This case study seeks to dispel the jobs/housing balance myths and expose the economic realities of this approach to balancing regional need.

Case G: Market Expansion – a market-lead expansion of the UGB is explored in this case study. Regional land use policies reflect the region's values and attempt to steer market demand in a direction that supports regional values. The market expansion case temporarily sets aside State Laws, Land Use Goals, and Metro Code to simulate the impact of unfettered regional growth. This case study serves as a comparison/contrast to how much land and where the region might expand if the market was the only controlling factor. This scenario provides important data about which policies may be needed to channel market forces to maximize regional values, regional growth, and the benefits of land use and transportation choices.

Closing Comments and Next Up...

The Metro Council has given authorization to analyze CASE A: The Base Case and CASE B: The I-5 Corridor Study. In each subsequent case, a set of demand and supply factors are allowed to freely change or maintained between some range of output. Each case treats the metering of land supply differently, for example by upzoning or adding land to the UGB in different ways and locations. Each case study may be thought of as a different means of testing a subregional allocation or accommodation of future need.

The table, next, summarizes the policy choice variables for crafting the input assumptions of each case study. Variables that have major policy impact are as follows:

- Urban Growth Report Demand Factors
- Environmental Protection
- Amendment of the Regional Transportation Plan
- Land Use Regulations (particularly upzoning)
- UGB amendments

The "urban growth demand factors" include the capture rates and refill rates. These rates are calculated inside the MetroScope model. As the model simulates future growth and urban development patterns in the region, these rates may vary. For example, if housing prices rise too rapidly, economic growth may be squeezed. The result may be the region experiences relatively higher amounts of redevelopment and infill but at the expense of pushing growth outside the Metro UGB.

Our work plan anticipates routine reporting intervals to you and the committee on the progress and results of our analysis. We will need direction from you on the following:

- Confirmation of case studies
- Input assumptions for each desired case study

We still have much to do and we have potentially many case studies to examine. Our objective is to complete the first phase of the MetroScope research – culminating in a "policy handbook" that details the assumptions, inputs, feedbacks, results and tradeoffs of each case study and comparisons across each for you to evaluate. Our goal is to get to you the technical information for you to make informed decisions that have merit and supported by sound technical analysis.

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MetroScope Input Memorandum

MetroScope Summary Worksheet

Case Studies

MetroScope Data Inputs: (P) means policy lever	UGR Inputs / Assumptions	A Base Case	B I-5 Trade Corridor Study	C Enhanced 2040 Centers	D Hold the UGB	E Damascus Community Plan	F Subreg-ional Jobs/ Housing Balance	G Market Expansion
Urban Growth Report Demand Factors								
Capture Rate -	70%	match to	allow shares to change					
Capture Rate -	82%	history	to Clark &					
Refill Rate -	28.5%							
Refill Rate - Industrial	21%	Provide supply of land						
Refill Rate - Commercial	52%	to match refill rates						
Environmental Protections								
In UGB	Title 3	Title 3	Title 3	Title 3	Title 3	Title 3	Title 3	Title 3
Out UGB (P)	200 feet	pseudo T3	pseudo T3	pseudo T3	pseudo T3	pseudo T3	pseudo T3	pseudo T3
Transportation Data (P)								
Financially Constrained	RTP	RTP	RTP	RTP	RTP	RTP	RTP	RTP
Additional Infrastructure	0	0	I-5 transport upgrades	raise capacity in centers	0	yes in Dam.	in growth areas	in growth areas
Land Use Regulations								
Zoning (SRZ)	1999 zoning	--------- Determine capacity based on January 2001 local zoning data in RLIS -----						
Upzone (e.g. Urban Centers)	0	0	0	yes in ctr.	yes	yes in Dam.	yes by area	0
Supply of ReFill								
Redevelopment	assumed	------ Refill supply replenishes based on changes in improvement value and land value ---						
Infill stock	available	------ Refill supply replenishes based on changes in improvement value and land value ---						
Regulatory upzone/more capacity	2040 upzone	0	0	yes in ctr.	0	yes in Dam.	0	0
Vacant & Buildable Lands Analysis								
Vacant Land/Supply	1998 data	--------- Buildable Land and Capacity is based on 2000 Vacant Land data in RLIS ------						
Land Filter Assumptions								
Residential	0	---------- MetroScope Land Filter picks out serviced and available supply ---------						
Non-residential	0	---------- Assumes 25% of total stock is made available in each 5 year increment --------						
UGB Amendments (in incremental steps)								
UGB expansion Add land according to scenario	Council Decision in 12/00	expand consistent with State law	same as base case	Expand in areas supportive of centers	No UGB expansion	Damascus area only	expnad based on Jobs /Housing Ratio	expand in high demand locations
Clark County Land Use & Capacity								
Vacant Land & local zoning		---------- Replenish as needed based on last 5 years conumption rate ---------						
Regional Forecast								
2000-2025 Regional	2020 Fcst.	--- Population and Employment Need (Demand) is derived from 2000-2025 Regional						

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MetroScope Summary Worksheet

Output Measures:

Case Study Decision Rules

MetroScope Policy Metrics / Policy objectives*	A **Base Case**	B **I-5 Trade Corridor Study**	C **Enhanced 2040 Centers**	D **Hold the UGB**	E **Damascus Community Plan**	F **Subregion Jobs/Housing Balance**	G **Market Expansion**
Land & Housing Prices	cap price appreciation to trend growth rate	same as base case	free to change	free to change	free to change	free to change	free to change
Regional Capture Rate							
Mixed Use Capture Rate	maintain in a narrow range consistent w/ UGR	free to change - test amount of growth to Clark county	free to change; MU rate should rise over time	free to change	free to change	free to change	free to change
Redevelopment Rate	start with amount of refill stock equal to UGR demand rate free to change in later years	same as base case	do not allow redev. rates to decline significantly below standard	same as base case	same as base case	same as base case	same as base case
Infill Rate	amount of refill stock equal to UGR demand rate free to change in later years	same as base case	do not allow infill rates to decline significantly below standard	same as base case	same as base case	same as base case	same as base case
Transportation accessibility measures	maintain in a narrow range consistent w/ UGR	improve accessibility through the I-5 corridor study area	improve accessibility to centers	free to change	improve accessibility to Damascus town center development	sustain accessibility to subareas of highest demand	free to change

* These five policy measures are the principal macro output indicators that describe the economic conditions for each case study.
These indicators provide an indication of some of the major trade-offs between each policy doctrine framed in each case.
The policy metrics and additional detailed policy measures (not listed) provide the Council with the information about how policies impact different parts of the regional economy in terms of costs, benefits, and tradeoffs of each case study.

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Case A. Base Case – Application of 2040 Policy Goals

Urban Growth Report Demand Factors:
- Capture rate – let vary but maintain the capture rate in the range of historical experience; the initial starting values for the capture rates should duplicate as close as possible with rates assumed in the UGR; subsequent five year increments should average in the last five years and this new rate should become the target
- Refill rates – provide an amount of redevelopment and infill stock (supply) equal to the historical estimates of the refill rates – let the case study determine how much of the inventory of available redevelopment and infill gets used in each 5 year period. Refresh the refill stock as land prices change (since land price is one of three factors in determining refill).

Environmental Resource Protection Options:
- Title 3 inside UGB; pseudo-Title 3 buffer outside UGB

Transportation Data:
- Priority (or strategic) Regional Transportation Plan (RTP)

Land Use Regulations – local cities and counties
- Local zoning as of January 2001
- No upzoning since local jurisdictions are already assumed to be in compliance

Supply of Redevelopment and Infill
- Refresh inventory of redevelopment and infill as land price changes
- No upzoning assumed
- Provide initial stock of refill land equal to assumption in UGR; supply amounts may then change as land prices change

Vacant & Buildable Lands Analysis
- 2000 Vacant Lands

Land Filter Assumption
- Expert panel to meter in available supply

UGB Amendments
- Use study areas defined in Alternatives Analysis
- Expand as needed to maintain moderate housing price appreciations

Clark County Land Use & Capacity, Neighboring City Capacity
- Expand Clark UGA as needed to maintain reasonable accessibility and level of service standard consistent with RTP
- Consider adding to Clark county's UGA consistent with past 5 years of growth.
- Use expansion areas tentatively mapped by Clark County staff for the case studies – these mapped areas do not necessarily represent the established will of Clark county policy makers
- Assume the capacity and the UGB's of neighboring cities expand every 5 years as needed based on the previous rate of land consumption.

Regional Forecast
- Unchanged across each case study – 2000-2025 Regional Forecast

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Case B. I-5 Trade Corridor Study – Application of 2040 Policy Goals and includes a series of interstate improvements

Urban Growth Report Demand Factors:

- Capture rate – let vary as dictated by the economic forces of the model. We want to know how changes in accessibility change Clark county's employment and housing allocations.
- Refill rates – SAME AS BASE CASE: initially provide an amount of redevelopment and infill stock (supply) equal to the historical estimates of the refill rates – let the case study determine how much of the inventory of available redevelopment and infill gets used in each 5 year period. Refresh the refill stock as land prices change (since land price is one of three key factors in determining refill).

Environmental Resource Protection Options:

- SAME AS BASE CASE: Title 3 inside UGB; pseudo-Title 3 buffer outside UGB

Transportation Data:

- Priority (or strategic) Regional Transportation Plan (RTP)
- Bi-state commission examining I-5 corridor issues will develop roadway, LRT, transit and bridge crossing alternatives to test

Land Use Regulations – local cities and counties / SAME AS BASE CASE

- Local zoning as of January 2001
- No upzoning since local jurisdictions are already assumed to be in compliance with 2040

Supply of Redevelopment and Infill / SAME AS BASE CASE

- Refresh inventory of redevelopment and infill as land price changes
- No upzoning assumed
- Provide stock of refill land equal to assumption in UGR

Vacant & Buildable Lands Analysis / SAME AS BASE CASE

- 2000 Vacant Lands

Land Filter Assumption / SAME AS BASE CASE

- Expert panel to meter in available supply

UGB Amendments / SAME AS BASE CASE

- Use study areas defined in Alternatives Analysis
- Expand as needed to maintain moderate housing price appreciations

Clark County Land Use & Capacity, Neighboring City Capacity / SAME AS BASE CASE

- Expand Clark UGA as needed to maintain reasonable accessibility and level of service standard consistent with RTP
- Consider adding to Clark county's UGA consistent with past 5 years of growth.
- Use expansion areas tentatively mapped by Clark County staff for the case studies – these mapped areas do not necessarily represent the established will of Clark county policy makers
- Assume the capacity and the UGB's of neighboring cities expand every 5 years as needed based on the previous rate of land consumption.

Regional Forecast / SAME AS BASE CASE

- Unchanged across each case study – 2000-2025 Regional Forecast

MetroScope Case Study Comparison Summary[1]

yes - Ph. 2

Measuring Success by 2040 Values	Base Case	I-5 Study	New Damascus Community	Enhanced 2040 Centers	Hold the UGB	Subregional Jobs/Housing Balance	Market Expansion
Efficient Use of Land	*						
Gross consumption of land: SFR/MFR/Com/Ind							
Housing density: acres and units							
Employment density							
Strong Economy	**						
Population/employment growth							
Housing and land price increases							
Focus Growth in Mixed Use Centers	**						
Mixed use index							
Capture rate for centers							
Protect Natural Resources	**						
Refill rate							
Development at the edge (w/in 1 mile)							
Air quality/ congestion/ travel speed (delay)							
Percent of tree canopy consumed by development							
Amount of development on steep slopes							
Balanced Transportation System	*						
Travel speed							
Modal targets							
VMT							
Congestion in target areas							
Diverse Housing Opportunities	**						
SFR/MFR splits							
Owner/renter rates							
Neighboring Cities	**						
Household growth outside the UGB							
Vibrant Community	**						
(complete community)							
Fiscal Health	*						
Tax base per capita							

- Land price - as input v. output, of infrastructure costs.
- Infrastructure Costs.

[1] *Rating per value: *- poor, ** no real change, *** improvement*

DRAFT

MetroScope Documentation

Model Overview

MetroScope is a set of decision support tools used by Portland Metro, the Portland, Oregon area's regional government, to model changes in measures of economic, demographic, land use, and transportation activity. MetroScope comprises four models and a set of GIS (geographic information system) tools that keep track of the location of activities and produce visual representations (maps) from the models' output. The four models that interact within the MetroScope framework are:

The **economic model**, developed and maintained by Dennis Yee, predicts region-wide employment by industry and the number of households in the region by demographic category (HIA, which assigns each household to one of 441 combinations of household-size category, income category, and age-of-household-head category).

The **travel model**, developed by Keith Lawton and maintained by Dick Walker, predicts travel activity levels by mode (bus, rail, car, walk, or bike). and road segment and estimates travel times between transportation analysis zones (TAZs) by time of day. It also produces a measure of the cost perceived by travelers in getting from any one TAZ to any other. This measure of perceived cost, called a "logsum", can be converted into a composite travel time that makes a minute on any particular route or mode (e.g., bus, light rail, drive alone, carpool, walk) equivalent in perceived cost to a minute on any other route or mode.

There are **two real estate location models**—one for residential location and one for non-residential location. Sonny Conder developed both, and Jim Cser maintains the residential location model. These predict the locations of households and employment respectively, and also measure the amount of land consumed by development, the amount of built space produced, and the prices of land and built space by zone in each time period.

The **GIS database and tools**, developed and maintained by Carol Hall and Karen Larson, contain the land and development data and maintain the spatial relationships between data elements. They also map data between different zone systems.

Purpose

In reality, travel, economic activity, location choice, and real estate development are all interdependent. People travel to where they work, shop, and recreate. Goods are hauled to where they are processed, warehoused, and sold. Businesses locate where they are allowed and where they have access to labor and raw materials as well as access to markets for their goods or services. People locate where they are allowed and where they have access to their place of work, shopping, schools, and recreation. People also place value on the attributes of a neighborhood, such as its crime rate, elevation, and noise level, and people often seek to locate near others with similar demographic characteristics. For both businesses and people, the relative price of a location is an important consideration in choosing where to locate and the absolute price determines where they can afford to locate. The overall level of economic activity in a region depends on the cost of production, including space rent, transport, and labor costs, relative to other regions.

The purpose of bringing the four models together into a single, integrated framework is to allow them to interact with each other, producing more accurate predictions of future conditions and allowing them to better reflect the full range of effects of policy decisions.

MetroScope allows the testing of a wide range of policy scenarios. Among its policy-sensitive inputs are:

- **Land Availability and Capacity**, including zoning and plan designations, environmental constraints, and the parameters used by the Land Filter to identify land that will be developed (see below).

- **Cost of Development**, including specifications of cost per square foot to build and SDCs (which can be redefined to incorporate other fees and permitting costs). Note that the price of land is determined within the model and is not an input.

- Assumptions about **changes in demographics** (income, age, and household size) can be applied through the economic model, as can assumptions about **changes in employment** (by industrial sector).

- Assumptions about **changes in transportation infrastructure and transit availability** can be applied through the travel model.

Interaction Between Models

MetroScope consists of four separate models, which interact within and between model iterations (five-year periods). Figure 1 shows the flow of information between the models.

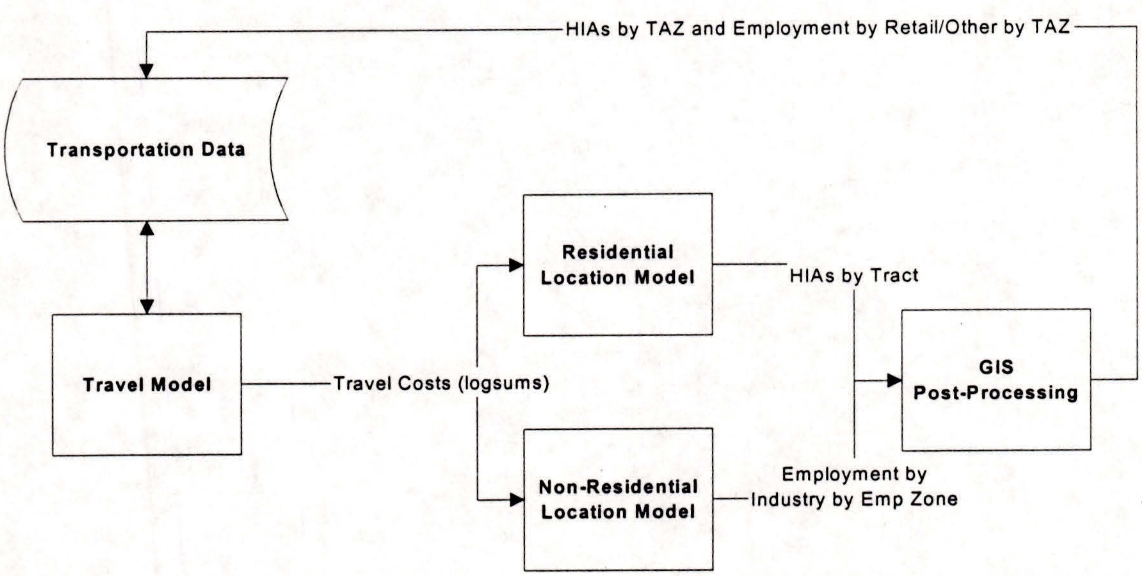
(Substitute Figure 1 for this page)

Interaction Between Location and Travel Models

Metro's travel demand model predicts trips and travel accessibilities between analysis zones. Documentation of the travel demand model is available in a separate report. The model is applied at a 1,260-zone system. When multimodal accessibilities at the zone-to-zone level are aggregated to the census tract-to-census tract level, they are weighted by the number of person-trips between each origin and destination zone pair. The multimodal accessibility measure (logsum) takes into account differences in perceived cost between different modes (e.g., bus, light rail, drive alone, carpool, walk) and routes. The reported accessibility is weighted by the proportions of person-trips on each combination of route and mode.

The travel model supplies both the residential and non-residential location models with a measure of the cost of getting from each zone to each of the other zones. This measure of relative accessibility affects where housing and employment growth will locate. The residential location model supplies the travel model with number of households, by demographic category, in each zone. The non-residential location model supplies the travel model with employment by retail/non-retail in each zone. These estimates of households and employment are used by the travel model to estimate trips and trip destinations.

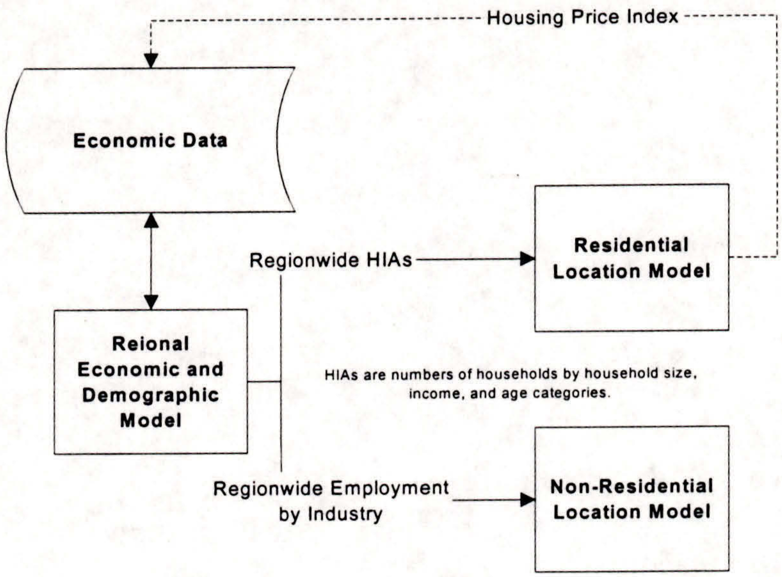
Figure 2: Data Flow between Location and Travel Models



Interaction Between Location and Economic Models

The economic model supplies the residential location model with the total number of households, by demographic category, in the region for each time period. It supplies the non-residential location model with the total number of employees, by industry, in the region for each time period. The residential location model supplies the economic model with a measure of region-wide housing prices, which can provide feedback to the overall level of regional growth.[1]

Figure 3: Data Flow between Location and Economic Models



Interaction with Land Data

Pre-Processing of Land Data

Metro's Regional Land Information System (RLIS) contains data describing and locating each parcel (tax lot) as well as overlaid information about political districts, zoning designations and constraints, environmental constraints, infrastructure, and geography.

The land data is pre-processed to identify vacant, developable parcels, redevelopable parcels, and portions of parcels that could be subdivided to allow additional (infill) development. Metro refers to development on non-vacant parcels as "refill" development. This pre-processor provides development capacity for each employment zone for the non-residential location model and for each residential zone (census tracts) for the residential location model.

[1] This feedback mechanism has not been implemented to date, but will be.

The real estate location models currently lack a model of the market for land. It is therefore necessary to determine outside the model how much land will be developed, and which parcels are likely to be redeveloped or infilled. This is accomplished in the pre-processing of land data. Four criteria are used:

1. Tax lot size
2. Improvement value
3. Land value
4. Total value

Zone-type-specific threshold values are specified for each of the criteria and parcels that meet all four tests are considered available for refill development capacity, which is used by the location models in the same way as vacant development capacity.

Appendix A lists and defines all of the data elements from the land database that are used by MetroScope. Appendix B describes how Metro determines which lands are vacant. Appendix C describes in more detail how land data are processed in MetroScope.

The Land Filter

As noted above, the real estate location models currently lack a complete model of the market for land. The model does incorporate a representation of the demand side of the market for land. Given a quantity of land to develop, it can report how high or low the price of land has to go to result in that much being developed. But because the model doesn't know how much land would be made available for development at any particular price, a market-clearing quantity of development cannot be determined. It is therefore necessary to determine outside the real estate location models how much land and which parcels will be made available for development in a given time period. This is accomplished in the Land Filter.

The land filter acts as a means of simulating the market supply function by identifying which of the parcels in the region are potentially developable during each five-year interval.[2] Just because a parcel passes through the land filter does not necessarily mean that the real estate location model will place any development on that parcel. Demand must exist and the land attributes must be suitable for the type of demand before the parcel is developed. The land filter behaves as a sieve for selecting which parcels are available for potential development. The quantities of land that could develop in each time period are determined by an expert panel and are an input to the model, not a prediction by the model.

[2] The model currently runs in five-year increments, so the land filter currently specifies how much land will be developed in each five-year period.

Two land filters are employed—one for residential land market and the other for the non-residential land market. Additional research is still necessary to develop an endogenous supply function or a routine that better simulates the availability of developable land.

Once the supply of available land is determined, the real estate location model is then capable of solving for a market-clearing quantity and price for real estate. The attributes of each parcel are then uniquely matched with the demand for land as given by the type of demand. If there are surpluses or deficits between supply and demand quantities, land and improvement prices are adjusted to strike a balance between supply and demand.

In the case of residential land, the available parcels are divided into six parcel-size categories and a "developability index" is calculated for each parcel. The variables that go into calculating the developability index are:

1. The amount of acreage in similar-sized parcels in the zone
2. The amount of vacant acreage in large parcels
3. A price factor
4. A new urban land infrastructure factor
5. A parcel-size-specific infrastructure factor

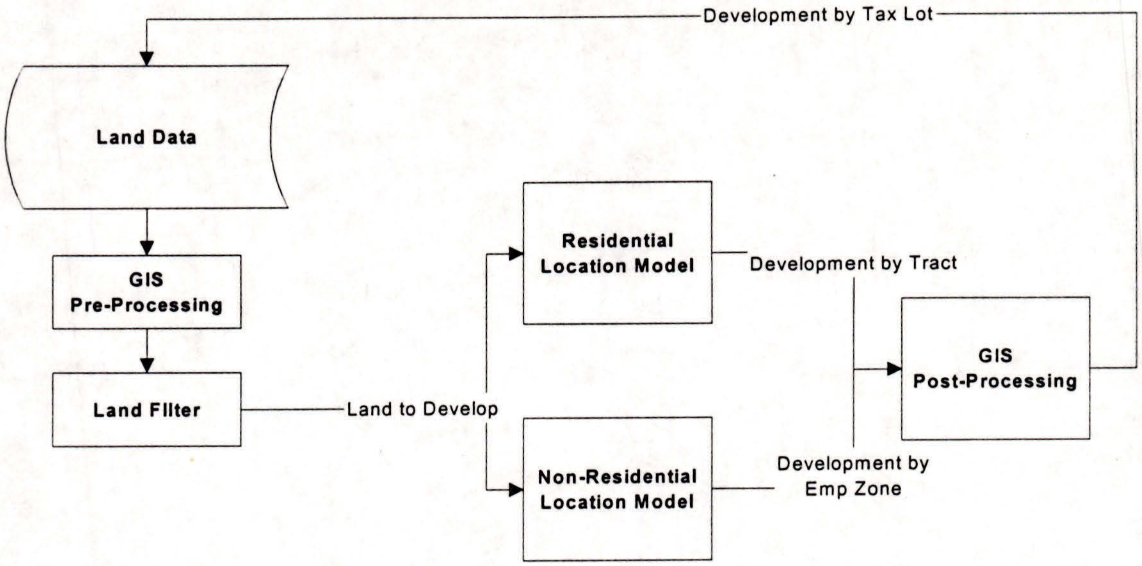
An expert panel helps identify the total amount of land that will develop and a cutoff value for the developability index is set to yield that much land. The cutoff value may be calibrated to produce stable land prices

In the case of non-residential land, the available parcels are divided into eight floor-area ratio (FAR) categories. A similar developability index could be developed and applied, but the Land Filter currently makes available 25 percent of the developable land in each FAR category in each time period

Post-Processing of MetroScope Output

After the location choice models have run, producing an allocation of housing and employment to each analysis zone, their output is fed back to the land database through the post-processing GIS component. The post-processor takes the zone-level information about development and assigns it to individual parcels (tax lots). For small parcels, it applies a one-to-one mapping of developed unit to parcel. For large parcels, it currently uses proportional assignment, but will be modified to perform synthetic subdivision of existing parcels. Appendix C describes in more detail how land data are processed in MetroScope.

Figure 4: Data Flow between Location Models and Regional Land Information System



Internal Workings of the Real Estate Location Models

The following descriptions of the residential and non-residential real estate location models provide an overview of how the models work and what variables they employ. Detailed definitions of the variables, functions, parameters, and estimated parameter values may be found in Appendices D and E.

Residential Model

The residential real estate location model works by adjusting price indices until the quantity of housing units demanded, by tenure (owner- or renter-occupied), housing type (single-family attached, single-family detached, or multi-family), and residential zone, matches the quantity supplied.

Households are the consumers in the residential model and households are characterized by dividing the total population of households into 64 categories, called HIAs. In the future, the number of HIA categories will be increased to 441, with seven categories for each of household size and age of household head, and nine categories of household income. Each household belongs to one category of household size, one income category, and one category of age of household head. There currently are 64, and will be 441, possible combinations of size, income, and age categories and every household is associated with one such combination. Table 1 shows the definitions and base-year shares for the HIA categories that will be used in the residential model.

Figure 5: HIA Categories

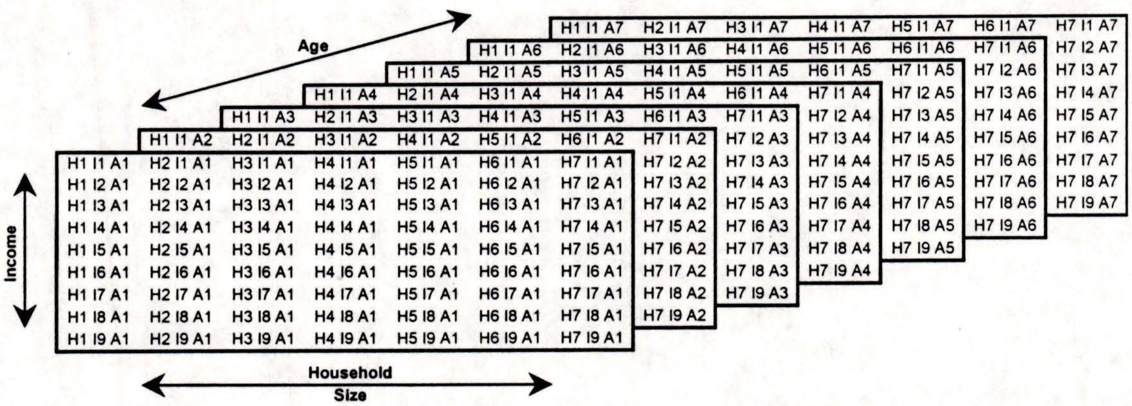


Table 1: Definitions of HIA Categories Used in Residential Model

Category	Range	Share
	Household Size (persons)	
H1	1	28%
H2	2	32%
H3	3	17%
H4	4	14%
H5	5	6%
H6	6	2%
H7	7 or more	1%
	Household Income (1989$)	
I1	under $5,000	6%
I2	$5,000 to 9,999	9%
I3	$10,000 to 14,999	9%
I4	$15,000 to 24,999	17%
I5	$25,000 to 34,999	16%
I6	$35,000 to 49,999	18%
I7	$50,000 to 74,999	14%
I8	$75,000 to 99,999	6%
I9	more than $100,000	5%
	Age of Household Head (years)	
A1	under 25 years	6%
A2	25 to 34 years	18%
A3	35 to 44 years	24%
A4	45 to 54 years	21%
A5	55 to 64 years	12%
A6	65 to 74 years	9%
A7	older than 75 years	10%

Housing units are characterized by tenure (owner- or renter-occupied) and type (single-family detached, single-family attached, and multifamily) and within each tenure class, each housing unit is assigned to one of eight price categories.

Residential zones inside the model area are census tracts. There currently are 328 internal residential zones and five external zones. The external zones are: Columbia County, Newberg, Yamhill County (except Newberg), North Marion County, and Salem, providing the means of estimating how much of the four-county residential demand is shifted outside the four-county region.

Every household needs a place to live, and the model maintains a one-to-one relationship between households and housing units. Populations living in group quarters or in homeless circumstances are not modeled. Households have a budget constraint, limiting the amount they can spend on housing. The model predicts how much households in each HIA category will spend on housing, given prices for housing and for other goods and services. This budget constraint currently is not used in the model, but may be examined after the model runs.

The housing demand component of the residential model determines, across all residential zones, how many units of each tenure type, housing type, and price level will be consumed given the composite regional price. It also determines the unit size and lot size for new construction.

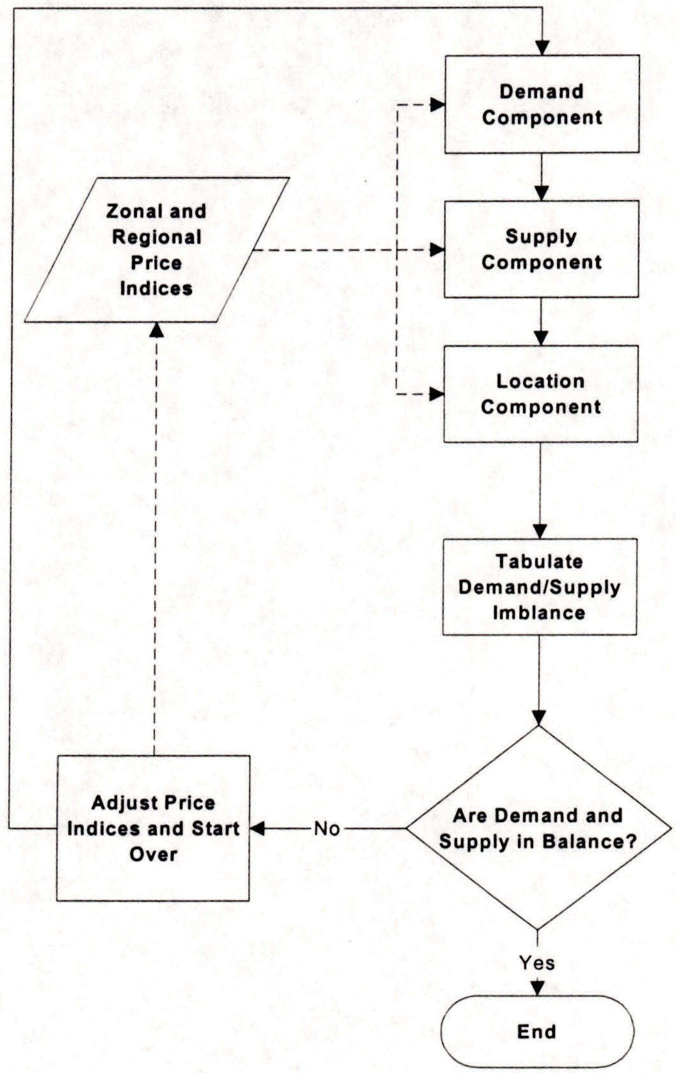
The supply component of the model determines how many of each type of housing unit to produce, and in which zones to produce them, in each time period. It also tracks the quantity and quality of existing stock.

The housing location choice component predicts the proportion of households in each combination of HIA category, tenure type, and primary worker employment zone that will locate in each residential zone, given neighborhood amenities and relative prices.

All of these components operate on a given set of price indices. The model works by:

- Estimating the regionwide quantity of housing units that will be demanded by tenure class, type, and price category in the Demand Component.
- Estimating the quantity of new units that will be built in each residential zone by tenure class, unit type, and price category, as well as estimating unit sizes, lot sizes, and amounts of buildable land consumed. The Supply Component also tabulates the total number of units, including existing units, in each combination of categories in each zone.
- Assigning households to residential zones, tenure class, unit type, and price category in the Location Component.
- Comparing the numbers of units by tenure class, unit type, and price category, that are available in each residential zone to the numbers of households assigned. If the difference is small enough, the model is done for the current time period. If not, the model adjusts the zone-price indices to reduce the difference between the number of housing units demanded and the number supplied, and starts over.

Figure 6: Process for Solving Residential Location Model



The Demand Component

The demand component predicts tenure percents for each HIA category, owner and renter prices for each HIA category, and the percents in each combination of unit type and tenure for each HIA category. It also predicts single-family house size (in square feet), rental unit size (in number of bedrooms), and number of earners per household for each HIA category.

No variable in the model directly measures a household's wealth. The age of household head variable picks up part of the wealth effect, though, resulting in much higher rates of home ownership for lower-income, older households than for younger households with the same income.

The demand component predicts the percent owning and prices as functions of:

- The demographic attributes represented by the HIA category
- A weighted regionwide rental price index
- A weighted regionwide house price index
- A regionwide transportation price index

It predicts percents for the unit types as functions of:

- The demographic attributes represented by the HIA category
- Housing prices and rent levels by unit type
- The differences between the price levels of single-family detached and other unit types

It predicts owner-occupied and rental unit sizes from the demographic attributes represented by the HIA category. It predicts the number of vehicles a household will own from its demographic attributes and price indices for rental prices, house prices, and transportation prices.

The Supply Component

The supply component performs a variety of accounting functions as well as predicting the quantity and type of housing that will be built. It tracks the vintage stock, the price distribution of vintage stock by zone, and land price distribution by zone. Vintage stock is tracked by unit type and price category and depreciation is tracked as the model moves through time.

The supply component incorporates all the costs of developing built space, including transaction costs, development fees, building permits, system development charges, and subsidies. The effects of policies that change these costs in general or for particular areas may be modeled by adjusting the relevant parameters.

The supply component estimates the price of land in a particular zone as a proportion of the average price in the region as a function of:

- Accessibility (from standardized travel times to all other zones)
- Whether the zone is an infill area or not
- Whether mixed uses are allowed
- Whether the zone has good views
- Whether the zone is prestigious
- The jurisdiction the zone is in
- The neighborhood the zone is in
- The average structure size in the zone
- The average structure age in the zone

The supply component estimates the capacity of a zone, measured in numbers of dwelling units, as a function of:

- The stock of vacant land in the zone
- The predicted number of dwelling units per acre, subject to regulatory restrictions
- The stock of land available for infill development in the zone
- The predicted rate at which infillable land will be consumed in the zone (a function of prices, demographic characteristics, average parcel size, and amount of nearby vacant land). Note that this rate is determined in the model and can vary over time as a result of policies and market factors
- The stock of land available for redevelopment in the zone
- The predicted rate at which redevelopable land will be consumed in the zone (a function of prices, demographic characteristics, average parcel size, and amount of nearby vacant land). Note that this rate is determined in the model and can vary over time as a result of policies and market factors
- The difference between existing and redeveloped capacity per acre in the zone
- Predicted demolition rates for single- and multi-family units in the zone (demolished units that are not redeveloped as residential) and corresponding lot sizes
- Predicted new construction in the zone (see below)

The supply component predicts the amount of new construction by tenure, unit type, and zone using the following procedure:

- Compare regionwide demand with regionwide supply.
- If demand exceeds supply, find, for each zone, the amount of demand that is for units whose price exceeds construction costs in this zone.
- In each zone, build the lesser of the number of units whose price exceeds construction costs or the capacity of the zone (see above).
- In each zone, distribute new construction to unit types based on share of demand.
- Add up total regionwide supply (including new units) and compare to regionwide demand. If there still is excess demand, record this amount. This amount is reported by the model and is of interest when evaluating the policy implications of a particular scenario. In particular it provides a measure of the amount of housing subsidies that will be required. This is measured as the difference between the number of units that the market would supply without a subsidy and the number of units required to provide each household with a housing unit.

Construction costs, by unit type and zone, are estimated as a function of:

- The greater of average single-family lot size in the zone or the minimum allowed lot size
- Land price in the zone
- Development fees in the zone
- The minimum structure size for the unit type
- Construction costs per square foot for the unit type
- A capital-land substitution parameter, which is a function of observed sales prices, lot sizes, and estimated land prices.

The Location Component

The location component distributes households to residential zones. It uses a logit framework, which assigns a probability to each of several discrete choices.[3] The probability of making any one choice is a function of the net value (benefits minus costs) of that choice to the consumer and the net values of all other choices. The net value is

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[3] For a set of three choices (a, b, and c), with net values of V_a, V_b, and V_c, respectively, the probability of choosing a is $\frac{e^{V_a}}{e^{V_a}+e^{V_b}+e^{V_c}}$, where e is the natural base (approximately 2.718). The natural logarithm of the denominator, called the "logsum" is a measure of the total value of all the available choices. Travel models use the logit framework extensively, as travel behavior can be described as a series of choices (e.g., destination choice, route choice, and mode choice). The "logsum" is the measure of accessibility that the travel model provides to both the residential and non-residential location models.

estimated from the attributes of the choices and of the consumer. In the logit framework, the probabilities always sum to one and, for a population of consumers with identical attributes (e.g., members of the same HIA category), the probability of one consumer making a particular choice also is the proportion of the population that will make that choice.

Households are assigned to employment zones for the primary worker. For each combination of employment zone, tenure class, and HIA category, the proportions of households that will live in each residential zone is determined in a logit framework where the net value of each choice (residential zone) is a function of:

- Household income and household income interacted with travel time to work
- The relative price of land in the residential zone interacted with income and with travel time to work
- The number of earners in the household and the number of earners interacted with travel time to work
- The relative house price in the zone
- Travel time to work and travel time to work squared
- The percentage of the regions housing units that have shorter travel times to work than those in the residential zone being evaluated

The work locations of additional workers in a household are not explicitly included in the model, but the number of workers in the household is, and households with more than one worker are less sensitive to the work location of the primary worker.

The location component can work iteratively with the travel model, with each adjusting to changes until a stable state is reached. The location model does work iteratively with the portion of the demand component that predicts regionwide tenure choice percentages.

The equations and parameter estimates for the residential location model may be found in Appendix D.

Non-Residential Model

The non-residential real estate location model works by adjusting price indices until the quantity of developed space demanded, by space type and employment zone, matches the quantity supplied.

In the non-residential model, employees are the consumers, acting as proxies for the firms that employ them. Each employee is associated with an industry. Firms or establishments (the portion of a firm that is at a particular address) are not directly represented in the model at all.

Unlike the residential model, which maintains a fixed, one-to-one correspondence between households and housing units, the non-residential model allows employees to consume varying numbers of square feet of space from a zone-wide pool of space of a particular type. The amount of space an employee consumes depends on the price of space and the relationship between price and quantity consumed can be different for each combination of industry and space type.

The distribution of an industry's employees among space types depends on the industry and the relative prices of space in different space types. The distribution of an industry's employees among employment zones depends on the relative prices of space in different zones and on the relative accessibility of the different zones to other business activity in general, to other business activity in the same industry, and to households, where employees come from.

The six space types used in the model are:

1. Manufacturing space
2. Warehousing space
3. Space for retailing and services
4. General office space
5. Space for medical uses
6. Space for government

There currently are 66 employment zones, the boundaries of which are shown in Figure 7. The employment zones are aggregations of census tracts and so are also aggregations of residential zones. There currently are no external zones in the non-residential model. The economic model that supplies the non-residential model with regionwide employment predictions does take into account real-estate market conditions within the region when predicting regional employment. Unlike in the residential model, where households that don't locate inside the region likely will locate just outside the region (many have jobs inside the region), areas that compete with Portland for business location are mostly far outside the region (e.g., Seattle, Austin, San Jose, etc.).

The quantity of space of a particular type supplied in a particular zone is a function of:

- The price index for that combination of space type and zone
- The cost of building that type of space
- The cost of buildable land in that zone
- Constraints on the amount of space per acre that is allowed to be built in that zone

Alternatives Analysis

(Substitute Figure 7 for this page)

Each space type has its own parameter for elasticity of substitution between capital and land and its own set of parameters that determine the cost per square foot of building space as a function of the floor area ratio (the ratio of built space to land area). These parameters are estimated and calibrated outside the model.

The quantity of space demanded is determined separately for each of 14 industries:

1. Agricultural Services
2. Construction
3. Nondurable Goods Manufacturing
4. Durable Goods, Metals, and Paper Manufacturing
5. High-Tech Manufacturing
6. Transport and Warehousing
7. Communications and Utilities
8. Wholesale Trade
9. Retail Trade
10. Finance, Insurance, and Real Estate
11. Consumer Services
12. Health Services
13. Business and Professional Services
14. Government

For each industry, the model estimates the quantity of space by space type demanded in each employment zone as a function of:

- The price indices for each combination of space type and zone
- Region-wide employment in that industry
- The proportion of employment in each space type when the price index is one.
- The square feet of space per employee in each space type when the price index is one.
- The number of acres of developed non-residential land in each employment zone (used in determining access)
- Travel costs to all other zones (used in determining access)
- Access to employment in all industries in all employment zones
- Access to employment in the same industry in all employment zones
- Access to all households in all employment zones.

Access is measured as weighted travel costs from all other zones where travel costs are logsums (see above) from the travel model converted to standardized minutes of travel time. A separate measure of access to employment in the same industry allows the model to capture the agglomerative tendencies exhibited by many industries.

Parameters in the demand function include:

- Cross price elasticities of demand (beta) for space types for each combination of industry and space type. The sum of all cross price elasticites is constrained to zero.
- A parameter (gamma) for each combination of industry and space type that relates the square feet per employee to the cost of space per square foot
- A parameter (alpha) for each combination of space type and employment zone that relates the location choice to relative prices between zones.
- A set of three parameters (A) for each industry that weight the three accessibility measures (accessibility to households, accessibility to all employment, and accessibility to employment in the same industry).
- A set of two parameters (B) for each industry that weight travel cost and travel cost squared in constructing the accessibility measures.

These parameters are estimated and calibrated outside the model.

The equations and parameter estimates for the non-residential location model may be found in Appendix E.

Sensitivity Analysis and Model Validation

As of this writing, MetroScope has not yet been run fully once. It is therefore not possible to report the results of sensitivity analyses or validation tests. The components of MetroScope, however have existed as standalone models before their incorporation into MetroScope. The Economic and Travel models have been extensively tested and the results of those tests are reported elsewhere. Earlier versions of the residential and non-residential location models were subjected to sensitivity tests and the residential location model was validated through an ex-ante forecast.

The sensitivity tests on the residential location model show that it is most sensitive to changes in the amount of land that is specified will develop in each model increment (five-year period). With too little available land (less than 12,000 to 14,000 acres in any five-year period), prices soar and expected growth cannot be accommodated. With too much available land, prices are driven down to unreasonable levels.

The non-residential location model is most sensitive to changes in access. For example, if routes crossing the Columbia River become too congested, employment in Clark County, Washington increases significantly, at the expense of employment in Portland's central business district and elsewhere on the Oregon side.

The residential location model also is sensitive to changes in access, whether they result from changes in the road system, the transit system, or just increasing congestion.

The residential location model, as it existed in 1997, was validated by running it from 1970 to 1995. Forecasts of the number of dwelling units in each district (the model then used 20 districts rather than the 328 internal and five external zones in the current version) for 1980 (ten years out) were off by an average of five percent, and forecasts for 1990 (20 years out) were off by an average of 20 percent.

Strengths and Weaknesses of MetroScope

MetroScope was designed to serve as a tool for evaluating land use and transportation policies by showing their effects on the location of households and businesses in the region. It also provides additional information of interest to policymakers, including housing construction and occupancy by tenure, type, size, lot size, and price, and non-residential development by use, square footage, floor-area ratio, and price. The travel model provides information about travel times, mode choice, and road-segment loadings. MetroScope does all this today, something few competing models can claim, and it does it at least as well as those few.

To achieve the goal of providing this type of information from available data and in a timely manner, certain trade-offs were made. The models work off available data, which limits the number and grain of the variables that may be included. And the location models lack a complete representation of the market for land, necessitating that the analyst specify how much land will be developed in each five-year period.

The limitations imposed by available data may be overcome by collecting and refining new data series. Metro's Data Resource Center has a process for identifying and prioritizing data development efforts. Over time, new variables can be added to the models to improve their accuracy. While this documentation was being written, variables were added to reflect urban renewal areas and known future changes in zoning.

The limitations imposed by the lack of a complete model of the market for land currently are addressed through the Land Filter. A better solution might be to add a representation of the land market to the location models. The Land Filter would still play an important role in selecting which of the available parcels develop first, but the model itself would determine how many of the available parcels get developed in any five-year period.

The supply of available land is already known to the model. There is a known quantity of land within the boundaries of each zone, and legal restrictions on the use of that land already are overlaid on it in the GIS database. The model currently knows of only one use for that land—development. By adding a representation of demand for other uses, the model could determine how much land will develop and how much will remain in other uses. Development demand can push the price of land up, and thereby obtain more land for development when the demand for development is sufficient, but lack of development demand cannot push the price of land below what alternative uses are willing to pay.

Many of the complications that result from different parcels having different development costs could be avoided by making those distinctions in the developer model. All land would be priced as bare, unimproved land in the land model. If a particular parcel already had sewer and water infrastructure in place, for example, their cost would be added in the developer model at what it would cost to add them, which is what developers would be willing to pay for them when they bought the land. Developers aren't indifferent to infrastructure availability or to other attributes that affect the speed and profitability of development, though. The Land Filter would still play an important role in identifying the parcels most likely to develop first.

Appendix A: Land Data Used by MetroScope

The following fields are extracted from Metros Regional Land Information System(RLIS) for use by MetroScope. The fieldnames preceded by an asterisk are publicly available in Metro's *RLIS Lite* distribution.

* TLNO	Parcel Identification Number
BLDGCLASS	Code for building use. Supplied by County Assessors. The categories vary by county.
LANDCLASS	Code for land use. Available for Clackamas County only; supplied by County Assessor. 31 categories.
* LANDVAL	Market value of the land in the parcel in dollars. Supplied by County Assessors.
* BLDGVAL	Market value of improvements on the parcel in dollars. Supplied by County Assessors.
* TOTALVAL	Sum of LANDVAL and BLDGVAL. (Note: Market values will be present for every occurence of a TLNO. Don't sum them up!)
PROP_CODE	Generalized landuse code from County Assessors.
* LANDUSE	Standardized PROP_CODE codes. Categories are: AGR (Agriculture), COM (Commercial), FOR (Forest), IND (Industrial) MFR (Multi-family residential), PUB (Public/semi-public), RUR (Rural), SFR (Single family residential), and VAC (Undeveloped).
* COUNTY	County in which parcel is located. Codes are: C (Clackamas), M (Multnomah), W (Washington), and R (Clark).
EXMCODE	Tax exempt code. Supplied by County Assessors. The categories vary by county.
* VAC	Code for vacant or developed status. Categories are: 1 (vacant), 5 (vacant, under site development), 8 (developed), and 0 (no data--rural). Note: partially vacant parcels are split into separate records.
AMTVAC	Indicates whether a vacant taxlot is fully or partially vacant. Categories are: F (fully vacant) and P (partially vacant).
* PLAN	Local Comprehensive Plan designation. Supplied by local jurisdictions. Categories vary by jurisdiction.

* JURNAME — Name of jurisdiction

* ZONE — Local zoning designation. Supplied by local jurisdictions. Categories vary by jurisdiction.

* UGB — Whether the taxlot is inside or outside the Urban Growth Boundary. Categories are: 0 (outside) and 1 (inside).

DGNTYPE — Metro 2040 design type designation.

* SLOPE — Indicator of steep slopes. Categories are: 25 (25% or greater slope) and 0 (less than 25% slope).

EXCEPT — Exception lands (land outside the UGB zoned for uses other than farm or forest. Categories are: 1 (exception land) and 0 (resource land--not exception land).

AREAPOLY — Area of the polygon in square feet.

ACRES — Area of the polygon in acres.

* CT — Census tract

* TAZ — Traffic analysis zone (1260 zone system)

* ZONE_CLASS — Aggregation of local zoning designations into 26 standardized designations. Categories are:

FF — Agriculture or Forestry- activities suited to commercial scale agricultural production, typically with lot sizes of 30 acres or more.

RRFU — Rural or Future Urban- residential uses permitted on rural lands or areas designated for future urban development, with minimum lot sizes of one acre or more.

SFR1 — Single Family 1- detached housing with minimum lot sizes from 20,000 quare feet and up.

SFR2 — Single Family 2- detached housing with minimum lot sizes ranging from 12,000 to 20,000 square feet.

SFR3 — Single Family 3- detached housing with minimum lot sizes ranging from 8,500 to 12,000 square feet.

SFR4 — Single Family 4- detached housing with minimum lot sizes from 6,500 to 8,500 square feet.

SFR5 — Single Family 5- detached housing with minimum lot sizes ranging from 5,500 to 6,500 square feet.

SFR6 Single Family 6- detached housing with minimum lot sizes from 4,000 to 5,500 square feet.

SFR7 Single Family 7- detached housing with minimum lot sizes ranging from 0 to 4,000 square feet.

MFR4 Multi-family 4- housing accommodating densities greater than 100 units. This is the densest of the multi-family zones and would require greater use of vertical space and buildings with multiple stories.

MFR1 Multi-family 1- housing and or duplex, townhouse and attached single-family structures allowed outright. Maximum net allowable densities range from 2 to 25 units per acre, with height limits usually set at 2 1/2 to 3 stories.

MFR2 Multi-family 2- housing accommodating densities ranging from 25 to 50 units per acre. Buildings may exceed three stories in height.

CN Neighborhood Commercial- small scale commercial districts permitting retail and service activities such as grocery stores and laundromats supporting the local residential community. Floor space and/or lot size is usually imited from 5,000 to 10,000 square feet.

CG General Commercial- larger scale commercial districts, often with a more regional orientation for providing services. Businesses offering a wide variety of goods and services are permitted and include highway and strip commercial zones.

CC Central Commercial- allows a full range of commercial activities typically associated with central business districts. More restrictive than general commercial in the case of large lot and highway oriented uses, but usally allows multi-story development.

CO Office Commercial- districts accomodating a range of business, professional and medical office facilities, typically as a buffer between residential areas and more intensive uses.

IL Light Industrial- districts permitting warehousing and light processing and fabrication activities. May allow some commercial activities.

IH Heavy Industrial- districts permitting light industrial and more intensive industrial activities such as bottling, limited chemical processing, heavy manufacturing and similar uses.

IMU Mixed Use Industrial- districts accommodating a mix of light manufacturing, office and retail uses.

IA	Industrial Area- districts designated exclusively for manufacturing, industrial, warehouse and distribution related operations.
MUC1	Mixed Used Center 1- combines residential and employment uses in town centers, main streets and corridors.
MUC2	Mixed Use Center 2- combines residential and employment uses in light rail station areas and regional centers.
MUC3	Mixed Use 3- combines residential and employment uses in central city locations. Mixed use is weighted toward residential development.
POS	Parks and Open Space
PF	Public Facilities
MFR3	Multi-family 3 - housing accomodating densities ranging from 50 to 100 units.

* PLAN_CLASS	Aggregation of local planning designations into 26 standardized designations. Categories are the same as for ZONE_CLASS above.
X-COORD	Latitude
Y-COORD	Longitude
* SCHL_DIST	School district property. Categories are: 1 (school district property) and 0 (not school district property).
* GOV	Federal, state, county or city government property. Categories are: 1 (government property) and 0 (not government property).
FUTURE_ZONE	Designations for future zoning for Damascus and Clackamas County.
TIER	Implementation phase for future zoning.
URB_RENEW	Urban renewal areas.

Appendix B: How Metro Determines Vacant Land

by Metro Staff

This procedure was developed by Metro's Data Resource Center for in-house use. The Vacant Lands Inventory is updated annually using orthorectified digital air photography. References are made to software and commands that are specific to ESRI's Arc/Info products.

PROCEDURE (OVERVIEW):

- 400 scale maps (checkplots) are created for each quarter township illustrating the previous year's vacant land, current taxlots, and geocoded building permits issued within 18 months of the date of the photography flight.
- Concurrently, orthophotos are printed at the same scale for each quarter township in the region.
- The two plots are overlaid on a light table and the checkplot is marked to reflect changes that occurred during the previous year.
- Those changes are then updated in the Vacant Lands coverage using on-screen-digital orthophotography, with the hardcopy marked-up map as a reference.

PROCEDURE (DETAILED):

STEP 1: CREATE PLOTS in groups of four sections (photo-id) for each of the air photos.

Run the following aml with a spool that includes all sections within the Urban Growth Boundary and current Urban Reserves.

Usage: &r /PARCEL/AML/VACLND <county> <photo Id>

STEP 2: LIGHT TABLE WORK:
Overlay the current orthophoto with last year's vacant lands map. Delineate areas of change or error. The geocoded building permits will act as flags to identify areas of development activity. These changes and corrections will be updated in the Vacant Lands coverage attribute "VAC".

"VAC" DEFINITIONS:

THE "VAC" DESIGNATION REFLECTS WHAT IS SEEN ON THE PHOTO, REGARDLESS OF THE PRESENCE OR ABSENCE OF TAXLOTS OR BUILDING PERMITS ON THE CHECKPLOT. DO NOT CONSIDER DEVELOPMENT POTENTIAL WHEN APPLYING THE FOLLOWING DEFINITIONS.

VAC = 1 - VACANT. The area is void of all permanent structures, landscaping, man-made features. It is agricultural, forested or otherwise undeveloped.

VAC = 5 - AREA UNDER SITE DEVELOPMENT. The area is in transition from vacant to developed. This is evident by ground clearing, streets or other utility features. No buildings are present. The taxlot basemap may or may not match the development pattern on the air photo.

VAC = 8 - DEVELOPED. All areas containing structures, including parking lots, landscaping, and any outbuildings on the taxlot. All parks and subdivision common areas are developed.

MARK-UP GUIDELINES:

- Delineate areas where errors or changes are apparent from the previous inventory. Typical flow of development occurs as VACANT --> UNDER SITE DEVELOPMENT --> DEVELOPED. The "UNDER SITE DEVELOPEMNT" stage is missed if it occurs during the year between photos.

- However, each lot should be evaluated independently since it is possible for a lot to return to VACANT from DEVELOPED. Care must be taken to evaluate the previous year's entire inventory against the current photography.

The Half Acre Rule

If a taxlot has a vacant portion that is 1/2 acre (100'x200') or larger, the lot is defined as partially vacant and partially developed. Delineate a polygon around the developed portion, which will include buildings, landscaped yards, etc. and code developed (vac = 8).
The remaining portion, (greater than 1/2 acre) is coded vacant (vac = 1).

PLOT MARK-UP CHECKLIST:

_____ Update the status of each taxlot from the previous year. Building permits act as a good flag to draw the eye to areas of activity.

_____ Correct errors from previous years.

- Consider back-of-lot vacant portions with the 1/2-acre rule.
- Check delineation of buildings and outbuildings on large lots.

_____ Mark polygons which extend beyond quarter township boundaries ONLY on the NORTH and WEST sides of the plot.

_____ Parks are developed. Subdivision common areas are parks.

_____ Streets - no differentiation between vacant and developed is necessary in streets.

_____ Check registration. Vacant land polygons should be properly registered to the taxlot base.

_____ Highlight sliver polygons.

_____ Spot-check the remaining areas for changes and/or errors. Look for lots that have changed from DEVELOPED to VACANT.

STEP 3: SCREEN DIGITIZE CHANGES identified on the check plot.

- Using the marked-up checkplot, make the identified updates and corrections to the VAC<current year> coverage in ArcEdit.

- The current air photo and tax lot lines will be used as back coverages to identify linework to be SELECTed and PUT into the vacant land coverage. Delete sliver polygons.

- If it is unclear whether a building exists due to excessive tree cover, etc, assessed building value can be used as a guideline.

- Adjacent vacant or developed polygons can be merged together, as long as the half-acre rule has been applied to each taxlot. Do not DISSOLVE the Vacant Lands coverages.

- When new polygons are created, add a label point and calc the item value for VAC to 1, 5, or 8.

- Upon completion of each quarter township checkplot, set DRAWENVIRONMENT to ARCINTERSECT and make intersection and node error corrections. SAVE, exit and run BLDERR* to a copy of the working coverage.

- Any label errors should be corrected on the copy.

- If the copy is error free, it becomes the edit coverage. Proceed to the next check plot until the township is complete.

- Save and build coverages often.

STEP 4: QUALITY CONTROL. In addition to the incremental QC topology checks described above, do a township-wide ARCPLOT polygonshade of the item VAC categories to ensure attributes are correct. Then RESELECT the same attributes in the old vacant land coverage and polygonshade them in the background. The shade patterns should be similar.

STEP 5: Rename previous year's vacant land in $<COUNTY>/county/vac as vac<year>. Add the new coverage to the central database as $<COUNTY>/county/vac.

Appendix C: How Land Data are Processed In MetroScope

by Sonny Conder

Transportation level of service and land availability are the two most important factors in determining urban development in MetroScope. This importance reflects the fact that in the actual urban real estate market, transportation and land are indeed the most important factors. Below we will discuss in detail how the land resource is used in the MetroScope modeling process. We have four classes of land resources divided by location and development density. These four classes of land resource are vacant urban land inside the four-county economic region, vacant rural land the within the four-county economic region, vacant urban land in Columbia, Marion and Yamhill Counties and redevelopment and infill urban land within the four-county economic region. Depending on economic and policy circumstances, all four classes of land are eligible to receive some of the growth forecast for the four-county economic region.

Land Data Tabulated at the Parcel Level.

All land resources in the four-county area are identified and evaluated at the tax lot level. Land not considered useable for residential and nonresidential real estate is excluded from the analysis. Excluded lands include bodies of water, wetlands, environmentally protected areas and areas reserved for exclusive farm and forestry uses. Data collected for each parcel include the present legally allowable capacity of the tax lot, the size of the tax lot, and economic data such as assessor's improvement and land value. In addition tax lots with governmental and nonprofit ownership are noted. All tax lots are assigned an x-y coordinate to insure precise spatial location along with label data indicating in which census tract and traffic analysis zone they are located. The exceptions to the above process are the five zones outside the four-county economic region. In these zones we assume an urban land capacity sufficient over a 20-year period to produce an additional 5,000 housing units in each zone.

At this point, all tax lots comprising developed urban land in the four-county economic region are scrutinized to determine their potential for redevelopment and infill ("refill"). Tax lots having at least one unit of capacity above their legal minimum are identified along with their improvement and land value. "Oversized" tax lots with improvement values below a stated minimum and land values greater than a stated minimum are included in the five-year available land resource. "Oversized" tax lots not meeting the improvement and land value criteria are retained in the database and reevaluated every five years as real estate prices change. Similarly, any rezoning that changes the legal capacity of a given area necessitates an additional data base query to identify the additional tax lots that may be "refill" candidates.

Land Resources Aggregated to Model Useable Form.

The real estate and transportation models cannot directly use the 600,000 plus tax lots that describe the land base of the four-county region. To make the data useable for the real estate models the residential land is aggregated into 328 census tracts plus five external zones. The nonresidential data are aggregated into 66 employment zones. Residential data are classified by parcel size and zoning capacity. Nonresidential lands are classified by zoning type and floor to area ratio categories.

Using a "Land Filter " to Proxy the Operation of the Raw Land Sub-market.

To this point we have compiled all the land resource available for an indefinite future time period. However, our growth models work on a five-year basis. What is critical to the modeling is the quantity and location of buildable land in a five-year period. At present the supply side of the models will provide additional land to the market as long as demand prices exceed supply cost. Real estate producers are conceptualized as income earners who must continue producing in order to earn income. Only when real estate producers costs exceed demand prices, will they cease production.

In reality much of the raw land market operates as a sub-market dominated by investors who maximize the value of the asset over time. As a consequence given falling or stable real estate prices, these investors remove raw land from the market or continue to require a selling price far above what developers can afford to pay. The result is that much less land becomes available for building than what the model calculates. A second complication involves the availability of infrastructure to make raw land buildable at urban densities. Planning, financing and building infrastructure requires considerable time particularly for former rural land that has been included within the Urban Growth Boundary.

In order to reasonably represent the raw land sub-market and the time lags in providing infrastructure we have implemented a "land filter" process that accounts for real estate price changes in each census tract, lot sizes and whether infrastructure is available. Rather than formally model these factors we are using a spreadsheet based algorithm to account for them and manually evaluating each census tract on a five-year basis using "expert" judgement on whether more or less raw land should be available in a particular area.

At present for nonresidential real estate we simply assume that under conditions of increasing or stable real estate prices 25% of the total nonresidential land resource will be available in each five-year period. For cases of slack demand and falling prices we greatly reduce that figure and conversely for cases of excess demand and increasing prices we increase the percentage.

Locating MetroScope Output on the Tax Lots Used in the Model.

MetroScope also uses a "post processor" that takes land use allocations made at the census tract and employment zone level and assigns them back to the individual tax lots used in the model. The basis of assignment is usually by land use designation with respect to land use type and allowable density. In this fashion MetroScope creates a synthetic landscape at the tax lot level and accounts for the land resource that was used to supply residential and nonresidential real estate growth.

Appendix D: Residential Model Equations and Parameter Estimates

Housing Demand Module
Housing demand stems from the regional change in households in each 5 year projection period. The change in households is subdivided by household size class, income class and age of head of household class. We can break each class into various groups which yields anywhere from 10 to 128 classes of household size, income and age. We refer to these household classes as "HIA's".

In this section of the model for each of the HIA classes we first compute tenure - rent or own- as a binomial choice as a function of HIA status and prices (adjusted as appropriate for location rent) of chosen, substitute and complimentary goods. We then compute for renters and owners an estimate of rent level or house price as a function of HIA status and prices of substitute and complimentary goods (again adjusted for location rent). For both owner and renter we compute for each HIA class the expected single family price and the expected monthly rent for each HIA class at each iteration of the model. We have specified the model for housing prices and rents to be a percent of an asymptotic maximum subject to an equilibrium price multiplier. This allows the housing price distribution to be updated to new initial conditions and allows it to vary robustly to changes in supply and demand growth.

For both owner and renter we estimate demand for three housing types - single family detached (traditional homes and manufactured homes), single family attached (row house, townhouse), and multifamily (condominiums, apartments). We are presently implementing the choice with multinomial choice equations for owners and renters. In the demand module we also estimate the size of owner occupied housing and the number of bedrooms of renter occupied housing as a function of HIA status and price. As an adjunct to the housing demand module we also calculate the number of earners and number of vehicles per household by HIA category.

All housing demand equations we specify in real dollar terms relative to 1995. Housing price changes relative to the 1995 baseline produce changes in tenure, house type, housing consumption (house size distribution) and lot size. We point out here that lot size changes as a result of both the house size distribution changing and producers changing the ratio of capital to land as the square foot prices of each change.

Housing Demand Equations:

A. Tenure computation by HIA class:

1.)
$$PRCNTOWN^{HIA} = \{EXP(-b_o - b_1(AGEHD) + b_2(AGEHDSQ) - b_3(INC) + b_4(INCSQ) + b_5(HSZE) + b_6(RX) - b_7(HX) - b_8(TX))\} / \{1 + EXP(-b_o - b_1(AGEHD) + b_2(AGEHDSQ) - b_3(INC) + b_4(INCSQ) + b_5(HSZE) + b_6(RX) - b_7(HX) - b_8(TX))\}$$

2.) $PRCNTRENT^{HIA} = [1 - PRCNTOWN^{HIA}]$

Where:

(All variables are in logarithms unless otherwise specified.)

$PRCNTRENT^{HIA}$: Percentage of each of the HIA classes that chooses to rent

$HSZE$: Household size class

$AGEHD$: Age of head of household

INC: Income level of household; measured at midpoint of class.

RX, HX, TX : Weighted rent, housing and transportation price index for area I at iteration K for a particular HIA category except for TX which is a constant within the region.

$AGESQ$: Square of age of head of household

$PRCNTOWN^{HIA}$: Percentage of each of the HIA classes that chooses to own.

B. House price and monthly rent computation by HIA class:

3.)
$$OWN : PRC_I^{HIA} = \langle\{EXP(b_o + b_1(AGEHD) - b_2(AGESQ) - b_3(INC) + b_4(INCSQ) - b_5(HSZE) + b_6(RX) + b_7(TX))\} / \{1 + EXP(b_o - b_1(AGEHD) + b_2(AGESQ) - b_3(INC) + .b_4(INCSQ) - b_5(HSZE) + b_6(RX) + b_7(TX))]\}\rangle (MAXPRC)(PRC_{IK} EQUILIBRIUMMULTIPLIER)$$

4.)
$$RENT : MRENT_I^{HIA} = \langle\{EXP(b_o - b_1(AGEHD) + b_2(AGEHSQ) - b_3(INC) + b_4(INCSQ) + b_5(HSZE) + b_6(HX) - b_7(TX))\} / \{1 + EXP(b_o - b_1(AGEHD) + b_2(AGESQ) - b_3(INC) + b_4(INCSQ) + b_5(HSZE) + b_6(HX) - b_7(TX))\}\rangle (MAXRENT)(PRC_{IK} EQUILIBRIUMMULTIPLIER)$$

Where:

$OWN{:}PRC_I^{HIA}$: For those choosing to own, the house price level that a give HIA class will pay in 1995\$. This amount is given as a.) a baseline with 1995 household expenditure and consumption patterns held constant, and b.) with real prices and consumption allowed to vary. Bid prices for each HIA class are grouped into 8 price classes l.

$RENT: MRENT_l^{HIA}$: For those choosing to rent, the monthly rent level that a given HIA class will pay in 1995$. This amount is given as a.) a baseline with 1995 household expenditure and consumption patterns held constant, and b.) with real rents and consumption allowed to vary. Bid rents for each HIA class are grouped into 8 rent classes l.

MAXPRC: An asymptotic limit on the price for the topmost price class.

MAXRENT: An asymptotic limit on the monthly rent for the topmost rent class.

$PRC_{IK} EQUILIBRIUMMULTIPLIER$: A constant for each area and tenure determined as part of the mathematical programming routine that shifts prices and rents up or down to satisfy the behavioral equations, identities and constraints of the program solution. In the baseline run this value is set at one; otherwise it may vary from .25 to 10. This factor, variable by geography, may be loosely interpreted as "location rent".

C. Housing type (single family detached, single family attached and multifamily) by tenure:

5.)

$$\begin{aligned} RENT:\%MFD^{HIA} = \{&EXP(-a_o + b_1(HSZE) + b_2(INC) - b_3(AGESQ) - b_4(RENT:MFD) \\ &+ b_5(MFD) - b_6(MFD*HSZE) - b_7(MFD*INC) \\ &+ b_8(MFD*AGESQ) + b_9(RENTDIFF:MFD))\} / \sum_m (RENTUTIL)_m \end{aligned}$$

6.)

$$\begin{aligned} RENT:\%SFA^{HIA} = \{&EXP(-a_o + b_1(HSZE) + b_2(INC) - b_3(AGESQ) \\ &- b_4(RENT:SFA) + b_5(SFA) - b_6(SFA*HSZE) - b_7(SFA*INC) \\ &+ b_8(SFA*AGESQ) + b_9(RENDIFF:SFA))\} / \sum_m (RENTUTIL)_m \end{aligned}$$

7.)

$$\begin{aligned} RENT:\%SFD^{HIA} = \{&EXP(-a_o + b_1(HSZE) + b_2(INC) - b_3(AGESQ) \\ &- b_4(RENT:SFD))\} / \sum_m (RENTUTIL)_m \end{aligned}$$

8.)

$$\begin{aligned} OWN:\%SFD^{HIA} = \{&EXP(a_o + b_1(HSZE) + b_2(INC) - b_3(AGESQ) - b_4(HPRC:SFD))\} \\ &/ \sum_{K=1}^{3} (OWNUTIL)_K \end{aligned}$$

9.)

$$OWN:\%SFA^{HIA} = \{EXP(a_o + b_1(HSZE) + b_2(INC) - b_3(AGESQ) - b_4(HPRC:SFA) - b_5(SFA) - b_6(SFA*HSZE) - b_7(SFA*INC) + b_8(SFA*AGESQ) + b_9(PRCDIFF:SFA))\} / \sum_{K=1}^{3}(OWNUTIL)_K$$

10.)

$$OWN:\%MFD^{HIA} = \{EXP(a_o + b_1(HSZE) + b_2(INC) - b_3(AGESQ) - b_4(HPRC:MFD) - b_5(MFD) - b_6(MFD*HSZE) - b_7(MFD*INC) + b_8(MFD*AGESQ) + b_9(PRCDIFF:MFD))\} / \sum_{K=1}^{3}(OWNUTIL)_K$$

Where:

(Variables are not in logarithms.)

$RENT:\%MFD^{HIA}$: Percent of households choosing to rent that choose multifamily dwelling units by HIA class.
$RENT:\%SFA^{HIA}$: Given rent choice and choice of single family, the percentage of renters choosing single family attached.
$RENT:\%SFD^{HIA}$: Percent of households in a particular HIA class choosing to rent single family detached dwelling units.
$OWN:\%SFD^{HIA}$: Percentage of owners choosing single family detached.
$OWN:\%SFA^{HIA}$: Percentage of owners choosing single family attached.
$OWN:\%MFD^{HIA}$: Percentage of owners choosing multi-family dwelling units.
SFD: Single family detached generic label: 1 if; 0 otherwise.
SFA: Single family attached generic label; 1 if; 0 otherwise.
$RENT:SFD,MFD,SFA$: Rent level by housing type
$RENTDIFF:SFA,MFD$: Rent difference between SFD and other housing types.
MFD: Multi family generic label; 1 if; 0 otherwise.
$HPRC:SFD,SFA,MFD$: House price by housing type.
$PRCDIFF:SFA,MFD$: House price difference between SFD and other housing types.
RENTUTIL: Total utility of renting – sum of SFD, MFD and SFA equations.
OWNUTIL: Total utility of owning – sum of SFD, MFD and SFA equations.

D. Single family house size, multi-family number of bedrooms, number of earners and number of vehicles per household equations

11.) $$OWNSZE = EXP(b_o - b_1(INC) + b_2(INCSQ) + b_3(HSZE) - b_4(HX))$$

12.) $$RENTSZE = EXP(-b_o + b_1(INC) - b_2(INCSQ) + b_3(HSZE) - b_4(RX))$$

13.) $$\begin{aligned} NVEHLS = EXP(-b_o + b_1(AGE) - b_2(AGESQ) + b_3(INC) - b_4(INCSQ) \\ + b_5(HSZE) + b_6(RX) - b_7(HX) - b_8(TX)) \end{aligned}$$

14.) $$\begin{aligned} NEARNS = EXP(-b_o + b_1(AGE) - b_2(AGESQ) + b_3(INC) - b_4(INCSQ) \\ + b_5(HSZE) - b_6(TX) \end{aligned}$$

Where:

(Variables are in logarithms.)

OWNSZE **:** Size in sq. ft. of newly constructed owner occupied housing by HIA and location.
RENTSZE : Size in number of bedrooms of newly constructed renter occupied housing by HIA and location.
NVEHLS : Number of vehicles per household by HIA and location.
NEARNS : Number of earners per household by HIA and location.

This completes the housing demand section of the model. The quantities above are then summed by HIA to arrive at demand totals at each model iteration for a particular jurisdiction for each 5 time period. As is indicated in the demand equations owner prices and monthly rents we adjust to be consistent with the production cost, location choice and location capacity sections of the model subject to the household expenditure constraint section documented below.

Household Budget Expenditure Constraint Module

Housing consumption, expressed as a percentage of the annual household budget devoted to it, varies markedly by income level and cross sectionally by level of housing prices and rents. Low income groups devote a higher proportion to housing than do high income groups. Moreover, households identical in size, income and age of head may devote dramatically different shares to housing depending on the relative cost of housing in the regions in which they live. Literature indicates that housing is a superior composite good with a very restricted and asymmetric elasticity of cross substitution between product types. In a word people need shelter almost before everything else and while people eagerly switch from renter to owner status whenever circumstances allow it, they almost never switch from owner to renter. Literature indicates that the short term price elasticity for housing consumption is very low; in other words it is very inelastic. Given excess demand prices will rise and an increasing share of household income will be devoted to housing. However, other work shows that the long term supply compensated price elasticity is roughly one. Given enough time to work and no restrictions on supply, the market will act to bring demand prices back to an equilibrium level. However, in regions with housing supply restrictions (cost of entry in the market is very high relative to demand) and for households whose demand price falls below the threshold level for new housing production long run price adjustment may never occur or may be very slow.

In the context of achieving price equilibrium in the regional housing market all of the above greatly complicates the *ex ante* housing demand equations we specified in the prior section. Based on our literature review and data from the *American Housing Survey* and the *Annual Survey of Consumer Expenditure* we constrained housing expense as a function of a set of 5 pseudo-translog consumer cost equations. The equations relate total housing expenditures and prices to all other household expenditures and prices. Based on data from both low and high housing cost regions the equations provide a realistic depiction of how household budgets adjust to changes in housing prices. In interpreting results however, we need keep in mind that the equations estimate <u>average</u> budget shares; not <u>marginal</u> budget shares. Households actually buying homes or renegotiating rent contracts may experience dramatically different cost impacts.

<u>Household Budget Share Equations</u>

15.)
$$\begin{aligned} FOOD = EXP(&b_o - b_1(INC) + b_2(INCSQ) + b_3(AGE) - b_4(AGESQ) + b_5(HSZE) \\ &- b_6(FDX) + b_7(FDX * HRX) - b_8(FDX * TX) \\ &+ b_9(FDX * HLX) - b_{10}(FDX * OTX)) \end{aligned}$$

16.)
$$\begin{aligned} HOUSE = EXP(&b_o - b_1(INC) + b_2(INCSQ) + b_3(AGE) - b_4(AGESQ) + b_5(HSZE) \\ &- b_6(HRX) + b_7(HRX * FDX) - b_8(HRX * TX) \\ &+ b_9(HRX * HLX) - b_{10}(HRX * OTX)) \end{aligned}$$

17.)
$$\begin{aligned} TRANS = EXP(&-b_o + b_1(INC) - b_2(INCSQ) - b_3(AGE) - b_4(AGESQ) + b_5(HSZE) \\ &+ b_6(TX) - b_7(TX * FDX) - b_8(TX * HRX) \\ &- b_9(TX * HLX) + b_{10}(TX * OTX)) \end{aligned}$$

18.)
$$\begin{aligned} HEALTH = EXP(&-b_o + b_1(INC) - b_2(INCSQ) - b_3(AGE) + b_4(GESQ) + b_5(HSZE) \\ &+ b_6(HLX) + b_7(HLX * FDX) + b_8(HLX * HRX) \\ &- b_9(HLX * TX) + b_{10}(HLX * OTX)) \end{aligned}$$

19.)
$$\begin{aligned} OTHER = EXP(&b_o - b_1(INC) + b_2(INCSQ) + b_3(AGE) - b_4(AGESQ) + b_5(HSZE) \\ &- b_6(OTX) - b_7(OTX * FDX) - b_8(OTX * HRX) \\ &+ b_9(OTX * TX) + b_{10}(OTX * HLX)) \end{aligned}$$

20.) $RX = RENT : MRENT_t \,/\, RENT : MRENT_{BB}$

21.) $HX = OWN : PRC_t \,/\, OWN : PRC_{BB}$

22.) $HRX = (RENTDU * RX + OWNDU * HX)/(RENTDU + OWNDU)$

Where:

(Variables are in logarithms.)

FOOD : Amount spent on food by HIA category by location.
HOUSE : Amount spent on housing including utilities, taxes, upkeep, furniture, etc. by HIA category by location in 95$.
TRANS: Amount spent on transportation of all types including travel away from home by HIA category by location in 95$.
HEALTH: Amount spent on health by HIA category by location.
OTHER: Amount spent on everything else by HIA category by location in 95 $.
FDX,HLX,OTX : Price indices for food, health and other. These are set as constants in the model and not changed.
TX: Transportation cost and travel speed index which measures both transportation cost and speed of travel. Valid at regional level only. (Cannot vary by location within the region).
RX, HX, HRX: Price indices for rental, owner and combined housing price index by HIA by location.
RENTDU: Total rental dwelling units by HIA by location for a particular model interation.
OWNERDU: Total owner occupied dwelling unts by HIA by location for a particular model iteration.

The above equation system allows housing prices and rents to change consistently in an *ex post* demand, supply and price equilibration. The *ex ante* price estimates we adjust with an "equilibrium price multiplier" which adjusts the bid price distribution up or down.

Neighborhood (Region) Vintage Housing, Initial Condition Accounting and Housing Production Module

Before we can estimate the producer response to the demand signals created in the housing demand and household budget constraint sections, we need estimate the vintage housing stock, capacity, vintage housing price distribution, and land price distribution for each neighborhood (region). These equations specific to whatever units of geography the model is being run for. They are updated at the beginning of each 5 year time period based on the relevant equilibrium price, demand and supply levels determined in the prior 5 year time period. Here we list the equations for single family only. Multi-family equations where relevant have the same structure.

We account for housing stock by type, geography and price (rent) category. The stock available at the beginning of the time period is the stock available at the end of the previous time period less depreciation out of the price (rent) category plus depreciation into the price (rent) category from more expensive stock. Depreciation in a given time period is a function of overall housing price change less than intrinsic depreciation rate.

The intrinsic depreciation rate we determine from the age coefficient of our hedonic price equations.

We determine the difference in land prices between areas as the residual between the estimated housing price (rent) and the "nonland" terms of our hedonic price equations. We express the relative prices as the ratio of particular areas to the region overall. The hedonic price equations we estimate from a sample of recent sales using variables to measure neighborhood, access and structure characteristics.

We recalculate capacity for each area for each time period. For a given land use (SFD or MFD) and zoning density class we calculate the DU capacity of vacant land. In addition we calculate the DU capacity from "infill" land. Infill and redevelopment rates we estimate as a function of the observed 1995 rates, housing prices and the potential return versus estimated current return on investment. These rates we multiply be the potential stock of infill and redevelopment acres in each area. The potential stock we estimate from our GIS which uses the particular attributes of each tax lot.

In the equations below we calculate vintage supply and depreciation for each housing tenure and housing type SFD, SFA and MFD though we show equations for only OWN:SFD. Depreciation is calculated for only SFD and MFD. SFA depreciation is assumed equal to SFD. Relative land price we calculate for only SFD with SFA and MFD given as a function of the SFD relative price factored for yield differences.

<u>Neighborhood Vintage Supply, Relative Land Price and Capacity:</u>

A. Vintage supply and depreciation:

23.)
$$NMBROWN:SFD_{ilt} = [(NMBROWN:SFD_{il,t-1})(1-DEPRC_{it})] + [(NMBROWN:SFD_{i,l+1,t-1})(DEPRC_{it})]$$

24.) $DEPRC_{it} = (PRC_{IK} / PRC_{BB}) - \Delta_i^{DUTYPE}$

25.) $\Delta_i^{DUTYPE} = -EXP(b_i(STRUCAGE)_i^{DUTYPE}$

Where:

$NMBROWN:SFD_{ilt}$: Number of single family detached dwelling units in jurisdiction (i), in price category (l), at time (t).
$DEPRC_{it}$: Depreciation rate in jurisdiction (i) at time (t).
Δ_i^{DUTYPE}: Annual depreciation rate estimated from hedonic price equations by jurisdiction and dwelling unit type (single family - multifamily).
$STRUCAGE$: Age of buildings from sample of housing sales included in hedonic price analysis.

B. Relative land price:

26.)

$$PLAND_{it}^{PZ} \,/\, PLAND_{Ot}^{PZ} = SFD\!:\!HEDPRC_{it} - [b_i(STRUCSIZE) + b_{i+1}(LOTSIZE) + b_{i+2}(STRUCTYPE)...+b_{i+n}(STRUCAGE)] \,/\, \tfrac{1}{N}\sum_{i=1}\{SFD\!:\!HEDPRC_{it} - [b_i(STUCSIZE + ...+b_{i+n}(STRUCAGE)]\}_i$$

27.)

$$SFD\!:\!HEDPRC_{it} = a_o + a_1(ACSSUTIL) + a_2(INFILL?) + a_3(MIXEDLU?) + a_4(VIEW?) + a_5(PRESTIGE?) + a_i(JURISDLABEL) + ...a_{i+n}(NEIGHLABEL) + b_i(STRUCSIZE)... + b_{i+n}(STRUCAGE)$$

Where:

$PLAND_{it}^{PZ} \,/\, PLAND_{Ot}^{PZ}$: Relative land price ratio measures the ratio of land prices in a particular jurisdiction to the average of all regional jurisdictions for land use type (*PZ*). This ratio is measured from the hedonic price equation by subtracting out structure and lot size effects from the actual selling price of housing.
$SFD\!:\!HEDPRC_{it}$: Single family sales price of housing in a particular jurisdiction at a particular time.
STRUCSIZE: Structure size in sq. ft. from house sales sample.
LOTSIZE: Lot size in sq. ft. from house sales sample.
STRUCTYPE: Structure type such as SFA, SFD, MFD.
STRUCAGE: Structure age in years from house sales sample.
ACSSUTIL: Access utility from zone *i* to all destination zones as a function of travel time and cost over all available modes.
INFILL?: Variable measuring whether neighborhood is infill area or not.
MIXEDLU?: Variable measuring whether neighborhood has mixed land uses or not.
VIEW: Measures whether a neighborhood has a view or not.
PRESTIGE?: Measures whether a neighborhood is a prestige area or not.
JURISDLABEL: Variable denoting which jurisdiction home sale is in.
NEIGHLABEL: Variable denoting which neighborhood a homes is located in.

C. Capacity calculations:

28.)

$$DUCAP_{itk}^{PZ} = (VACANTLANDSTK)_{itk}^{PZ}(DUACRE)_{itk}^{PZ} + \Phi_{it}^{PZ}(INFILLLANDSTK)_{it}^{PZ}(DUACRE)_{itk}^{PZ} + \Gamma_{it}^{PZ}(REDEVLANDSTK)_{it}^{PZ}(NETREDEVDUACRE)_{itk}^{PZ}$$

29.)

$$VACANTLANDSTK_{it}^{PZ} = (VACANTLANDSTK)_{i,t-1}^{PZ} - \sum_{l=1}^{8}(NEWCON:OWN+)_{i,l,t-1}^{PZ} \sum_{n=1}^{7}\sum_{HIA=1}^{64}(LOTSZE)_{i,t-1}^{PZ,HIA} - \sum_{l=1}^{8}(NEWCON:RENT)_{i,l,t-1}^{PZ}(MFCONSTANTLOTSZE) + (SFDEMO + MFDEMO)_{i,t-1}^{PZ}(CONSTLOTSZE)$$

30.)

$$INFILLLANDSTK_{it}^{PZ} = (OVRSIZELOTINVENTORY)_{it=0}^{PZ} - \sum_{t=t-n}^{t}\Phi_{it}^{PZ}(INFILLLANDSTK)_{it}^{PZ}$$

31.) $$\Phi_{it}^{PZ} = K_{95}(PRC_{it}^{PZ} / PRC_{95}^{PZ})^{a}(LANDCHAR_{it}^{PZ})^{b}(DEMOCHAR_{it})^{c}$$

32.)

$$REDEVLANDSTK_{it}^{PZ} = (REDEVLANDINVENTORY)_{i,t=0}^{PZ} - \sum_{t=t-n}^{t}\Gamma_{it}^{PZ}(REDEVLANDSTK)_{it}^{PZ}$$

33.) $$\Gamma_{it}^{PZ} = C_{95}(PRC_{it}^{PZ} / PRC_{95}^{PZ})^{a}(LANDCHAR_{it}^{PZ})^{b}(DEMOCHAR_{it})^{c}$$

Where:

(Variables are not in logarithms.)

$DUCAP_{itk}^{PZ}$: Dwelling unit capacity of area (*i*) in time (*t*) for land use *PZ* for tenure *k*.

$VACANTLANDSTK_{it}^{PZ}$: Vacant land stock in time *t* of jurisdiction *i* for land use *PZ* taken from prior iteration or from the RLIS data base in the initial time period.

$DUACRE_{it}^{PZ}$: The calculated yield per acre on land by parcel size, land use category and housing type, jurisdiction and time period subject to lot sizes not falling below the regulatory minimum size or above the regulatory maximum size.

Φ_{it}^{PZ}: The estimated rate at which the stock of infill land is consumed for each jurisdiction, time period and land use.

$INFILLLANDSTK_{it}^{PZ}$: Infill land stock for each jurisdiction, time period, etc.

Γ_{it}^{PZ}: The estimated rate at which the stock of redevelopment land is consumed for each jurisdiction, time period and land use.

$REDEVLANDSTK_{it}^{PZ}$: Redevelopment land stock for each jurisdiction, etc.

$NETREDEVDUACRE_{it}^{PZ}$: Net increase in capacity per acre of redeveloped land

$NEWCON : OWN : RENT$: New construction of owner and renter dwelling units by jurisdiction, time period and price (rent) class.

MFCONSTANTLOTSZE: Lot size assumption for multi-family

SFDEMO, MFDEMO: Number of single family and multi-family units demolished each period that are not redeveloped.

CONSTLOTSZE: Constant lot size assumption for demolished structures.

OVERSZELOTINVENTORY: Established by RLIS and expert committee in base year.

REDEVLANDINVENTORY: Established by RLIS and expert committee in base year.

LANDCHAR: A vector of land characteristics including average parcel size, site access and amount of vacant land within 500 ft.

$DEMOCHAR$: A vector of demographic characteristics such as average age, household size, etc. indicative of willingness to develop surrounding land to a higher intensity.

PRC_{it}^{pz}: The calculation from the hedonic equations of the parcel value in the maximum allowable use in a particular area in time t for a particular land use. Limited to the stock of vacant, infill and redevelopable parcels.

PRC_{95}^{PZ}: The calculation from the hedonic equations of the parcel value in terms of its current use.

K_{95}: The observed infill rate as of the 95-96 survey.

C_{95}: The observed redevelopment rate as of the 95-96 survey.

Housing Production and Supply

In this section we list the equations for determining the minimum housing price (rent) at which producers will enter the market (construction cost). We also list equations for determining the single family lot size and land price per sq. foot. Beyond equations which represent how private producers will respond to price, regulation, fee and capacity conditions in each area in each time period, we also include in this section the accounting equations for adding new construction to the vintage supply.

We also estimate the distribution of owner occupied house and lot sizes for each HIA class. We distribute each price category of owner occupied housing demand according to the observed size distribution in 1990 (or alternatively the 1995 - 96 distribution observed for new sfd construction). Similarly we assign each owner occupied house size category to a lot size frequency distribution observed in 1990 (or alternatively the 1995 - 96 distribution for new sfd construction). In each 5 year projection period the lot size distribution for each housing size category changes in response to changes in housing prices as housing price changes work back into land prices as a function of the capital-land substitution parameter in the housing production equations.

A. Calculation of Housing Construction Cost, Lot Size and Land Price per Sq. Ft.

34.) $IF:(SFLOTSZE)_{it=0}^{DUTYPE}\,\delta_{it} > MINLOTSZE_{it}^{DUTYPE}$

$$CONSTCOST_{itp}^{DUTYP} = K_o[K_{LND}(SFLOTSZE)_{i,t=0,p}^{DUTYPE}(LANDPRCRATIO)\delta_{it})]$$

35.) $$+(DEVELOPFEES)_{it}^{DUTYPE} + (LANDCAPCOST)_{it} + (STRUCTCAPCOSTSQFT)_{pt}^{DUTUYPE}(MINSTRUCTSQFT)_i^{DUTYPE}$$

36.) $IF:(SFLOTSZE)_{it=0}^{DUTYPE} < MINLOTSZE_{it}^{DUTYPE}$

$$CONSTCOST_{itp}^{DUTYPE} = K_o[K_{LND}(MINLOTSZE)_{it}^{DUTYPE}(LANDPRCRATIO)]$$

37.) $$+(DEVELOPFEES)_{it}^{DUTYPE} + (LANDCAPCOST)_{it} + (STRUCTCAPCOSTSQFT)_{p,t}^{DUTYPE}(MINSTRUCTSQFT)_i^{DUTYPE}$$

38.)

$$\delta_{it} = \left(\begin{array}{c} STRUCTSQFT_{i,t=0} / \{[(STRUCTSQFT_{i,t=0} / SFLOTSZE_{i,t=0}) \\ /(STRUCTCAPCOSTSQFT_{t=0} / LANDCOSTSQFT_{t=0})]^{-\Psi} \\ [(STRUCTCAPCOSTSQFT_{t=0}) / (LANDCOSTSQFT_{t=0})(LANDPRCRATIO)]^{-\Psi}\} \\ / SFLOTSZE_{i,t=0} \end{array}\right)$$

39.)

$$LANDPRCRATIO_t = [(OWN{:}PRC_{i,t=n} / LOTSZE_{i,t=n}K_O)^{1/\Psi+1}] / [(OWN{:}PRC_{i,t=0} / LOTSIZE_{i,t=0}K_O)^{1/\Psi+1}]$$

40.) $$\Psi = \left(\begin{array}{c} Ln\{\{\{[SFDPRC-(LOTSZE)(HEDLANDPRC)]/LOTSZE\} \\ -K_O\}/(HEDLANDPRC)\} \end{array}\right)$$

41.) $LOTSZE_{i,t=n} = \delta_{it}(LOTSZE_{i,t=0})$

Where:

(Variables are not in logarithms.)

Ψ : Capital-Land substitution parameter estimated assuming CES production function and land cost per sq. ft. estimated as residual from hedonic pricing model.

$LANDPRCRATIO_t$: Land price per sq. ft. at time t in area for a given lot size.

K_o, K_{LND}, K_O: Arbitrary constants necessary to initialize the values to the baseline conditions

MINSQFTLOTSZE: The minimum lot size for a particular DU type allowed under the regulations.

$DEVELOPFEES_{it}^{DUTYPE}$: Development fees charged by each jurisdiction by dwelling unit type and density if applicable.
$LANDCAPCOST_{it}^{DUTYPE}$: Developer's direct capital costs to develop a lot of a particular dwelling unit type
$STRUCTCAPCOSTSQFT_{t}^{DUTYPE}$: Capital cost per sq. ft. to build a particular type structure.
$MINSTRUCTSQFT_{t}^{DUTYPE}$: The minimum structure size for a particular DU type consistent with present building patterns.
$SFLOTSZE_{i,t=0}$: Single family lot size distribution in a particular jurisdiction in the base period.
SFDPRC: Single family sales prices observed in data used to estimate hedonic sales price model.
HEDLANDPRC: Land prices estimated from structural coefficients of hedonic sales price model.

B. Housing Supply and New Construction Determination Algorithm

Using owner occupied SFD, SFA and MF as an example we compare total demand from the demand equations with vintage supply. Next we determine the excess demand the price of which exceeds the cost of construction. This excess demand equals new construction if it is less than or equal to the capacity of the zone. If new construction requirements exceed the capacity of the zone, the remaining capacity available above the cost of construction is assigned to new construction. New construction is allocated by type in proportion to each housing type's share of demand. Finally, we compare total original demand to the new supply to determine if excess demand exists in the zone. If so, the excess demand is assigned to the "subsidy required" category.

$$DMD:OWN_{i,l,t} = (OWN:SFD_{i,l,t}) + (OWN:SFA_{i,l,t}) + (OWN:MFD_{i,l,t})$$

42.)

$$SUPPLY:OWN_{i,l,t-1} = NMBROWN:SFD_{i,l,t-1} + NMBROWN:SFA_{i,l,t-1} + NMBROWN:MF_{i,l,t-1}$$

$$FOR:DMD:OWN_{i,l,t} \geq CONSTCOST_{i,t}^{OWN}\ AND > SUPPLY:OWN_{i,l,t-1}\ THEN:$$

43.) $NEWCON:OWN_{i,l,t} = DMD:OWN_{i,l,t} - SUPPLY:OWN_{i,l,t-1}$

44.)

$$IF:NEWCON:OWN_{i,l,t} < \sum_{DUTYPE}^{3} DUCAP_{i,t,k}^{DUTYPE}\ for\ all\ l > CONSTCOST_{i,t}^{OWN}$$

$$THEN:TSUPPLY:OWN_{i,l,t} = NEWCON:OWN_{i,l,t} + SUPPLY:OWN_{i,l,t-1}$$

45.)

$$IF:NEWCON:OWN_{i,l,t} > \sum_{DUTYPE}^{3} DUCAP_{i,t,k}^{DUTYPE}\ for\ all\ l > CONSTCOST_{i,t}^{OWN}$$

$$THEN:TSUPPLY:OWN_{i,l,t} = \sum_{DUTYPE}^{3} DUCAP_{i,t,k}^{DUTYPE} + SUPPLY:OWN_{i,l,t-1}$$

46.) $NEWCON:SFD_{i,l,t} = [NEWCON:OWN_{i,l,t}][OWN:SFD_{i,l,t} / \sum_{K=1}(OWN_{i,l,t})_K$

47.) $\begin{array}{l} IF:DMD:OWN_{i,l,t} \leq CONSTCOST_{i,t}^{OWN}\ OR < SUPPLY:OWN_{i,l,t-1}THEN: \\ TSUPPLY:OWN_{i,l,t} = SUPPLY:OWN_{i,l,t-1} \end{array}$

48.) $XCSDMD:OWN_{i,l,t} = DMD:OWN_{i,l,t} - TSUPPLY:OWN_{i,l,t} IF > 0$

49.) $SUBSIDY:OWN_{i,l,t} = XCSDMD:OWN_{i,l,t}$

Where:

(Variables are not in logarithms.)

$TSUPPLY:OWN_{i,l,t}$: Total supply at time *t* of owner occupied housing.

$SUPPLY:OWN_{i,l,t-1}$: Housing supply at time *t*-1.

$OWN:SFD_{i,l,t}, OWN:SFA_{i,l,t}, OWN:MFD_{i,l,t}$: The total demand for single family detached, single family attached and multi-family detached for a particular jurisdiction in a particular price (rent) class.

$DMD:OWN_{i,l,t}$: Total vintage plus incremental demand by dwelling unit total, price category, jurisdiction and time period.

$SUPPLY:OWN_{i,l,t}$: Total vintage plus incremental supply by dwelling unit type, price category, jurisdiction and time period.

$XCSDMD:OWN_{i,l,t}$: Excess demand remaining after demand-supply reconciliation by price (rent) category

$SUBSIDY:OWN_{i,l,t}$: Housing demand that the private market will not supply without a subsidy.

Household Location Choice Given Place of Employment of Primary Earner

At this stage in model development we take the value (E_j^{HIA}) as given. In this notation (E) represents the employment in zone (j) by HIA class. As noted in the introduction we allocate employment using the econometric model and an expert panel using data generated from GIS, RELM and the transportation model. The exogenous estimate of employment in each zone is converted into an estimate of total households by HIA category. The model then determines tenure choice for the households working at each employment center. The household location choice module then determines location choice by tenure for each employment zone. So for a given number of households of a particular HIA category working in E_j, we specify their location choice as:

50.) $HSHLDS_{jk}^{HIA} = [\sum_{j=1}^{y} HSHLDS_j^{HIA} / \sum_{j=1}^{x} E_j^{HIA}] \times E_j^{HIA} \times PRCNTRENT^{HIA}$

51.)

$$HSELOC_{ijk}^{HIA} = \left(\frac{\begin{array}{l} EXP[-b_o - b_1(INC) - b_2(INC * TRAVELMIN_{ij}) + b_3(PLAND_{i,t} / PLAND_{O,t}) * (INC) \\ + b_4(NEARNS) + b_5(NEARNS * TRAVELMIN_{ij}) \\ - b_6(PRC_{IK} EQUILIBRIUMMULTIPLIER_{iK}) \\ + b_7(PLAND_{i,t} / PLAND_{O,t}) * (TRAVELMIN_{ij}) - b_8(TRAVELMIN_{ij}) \\ - b_9(TRAVELMINSQ_{ij}) - b_{10}(HSEOPP_{nm,t})] \end{array}}{\begin{array}{l} \sum_{i=1}^{y} \{EXP[-b_o - b_1(INC) - b_2(INC * TRAVELMIN_{ij}) + b_3(PLAND_{i,t} / PLAND_{O,t}) * (INC) \\ + b_4(NEARNS) + b_5(NEARNS * TRAVELMIN_{ij}) \\ - b_6(PRC_{IK} EQUILIBRIUMMULTIPLIER_{iK}) \\ + b_7(PLAND_{i,t} / PLAND_{O,t}) * (TRAVELMIN_{ij}) - b_8(TRAVELMIN_{ij}) \\ - b_9(TRAVELMINSQ_{ij} - b_{10}(HSEOPP_{nm,t})]\}_i \end{array}} \right) \times (HSHLDS)_{jk}^{HIA}$$

Where:

(Variables are not in logarithms).

$HSEOPP_{nm,t}$: Intervening housing opportunities measure which represents the percentage of the region's housing units that can be reached in a shorter travel time than the units in the area being evaluated.

$HSHLDS_{jk}^{HIA}$: Households of tenure k and HIA category employed in employment zone j.

E: Total regional employment

E_j^{HIA}: Employment in HIA class in employment area j.

$HSELOC_{ijk}^{HIA}$: Number of households of HIA class , tenure class k, working in area j who chose housing location i.

$TRAVEMIN_{ij}$. Travel time in minutes peak am from location i to employment zone j.

The household location choice model we specify to work recursively with the transportation model. The location choice model provides the transportation model with updated information on HIA's and employment by traffic analysis zone. The transportation model in turn calculates traffic flows, modes splits and new estimates of travel time between each traffic analysis zone for each mode. This information in turn provides the travel time data for the location model in the next time period.

Note that we specify the location model to be scale invariant. The utility of a location we estimate from the perspective of one household making a choice. From the perspective of a particular location the probability of the calculated choice occurring is a scale invariant function including only arguments relevant to the individual household decision. Demand and supply (capacity of the location at a particular price level) adjust through the location rent term $PRC_{IK}EQUILIBRIUMMULTIPLIER$.

Mathematical Programming for *Ex Post* Equilibrium

Each iteration of the model equations outlined above yields by jurisdiction (i) and time period (t) changes in land prices and housing prices (rents) as well as changes in tenure, lot sizes and housing sizes. To adjust demand and supply using price we calculate *RX, HX,* and *HRX* for each area that minimizes the difference between supply and demand. To do this we use a mathematical programming technique that determines an equilibrium multiplier (location rent) for each area and tenure that most efficiently adjusts supply, demand and price/rent in each area.

A. Mathematical Programming:

Given that we have established a set of baseline conditions (1995 economic conditions with the price (rent) ratio set equal to 1, we then operate the model in a mathematical programming framework to determine an equilibrium price level for the entire region. As presently implemented we determine a price equilibrium multiplier for each area i and tenure as follows:

52.) $FIND: \quad (PRC_{IK}EQUILIBRIUMMULTIPLIER) \quad SUBJECT\ TO:$

53.) $\sum_{i=1}^{n} \sum_{l=1}^{2} (SUPPLY_{i,l} - DMD_{i,l})^2 = MIN$

54.) $SUPPLY_{i,l} \geq 0$

55.) $DMD_{i,l} \geq 0$

56.) $PRC_{IK}EQUILBRIUMMULTIPLIER > .5 < 8$

57.) $\sum_{i=1}^{n} \sum_{l=1}^{2} SUBSIDY_{i,l} = 25{,}000$

Program conditions 1.) through 5.) are sufficient to obtain *ex post* estimates consistent with the equation system outline above and implicit in condition 6.). Please note that when the constant term in condition 6.) is set at 0, then total housing demand and supply are equated; which is the classical price equilibrium condition. However, in reality we find that without substantial subsidy that condition is never met.

PART THREE

Tables of Parameter Estimates:

Equation Number	1.)		3.)		4.)		5.)		6.)	
Dependent Variable	*prcntown*		*own:prc*		*rent:mrent*		*rent:%mfd*		*rent:%sfa*	
Estimation Method	*WLS*		*WLS*		*WLS*		***WRLS***		*WRLS*	
RSQ.	*.92*		*.88*		*.85*		*.40*		*.40*	
Data Source	*Cons. Ex. S.*		*Cons. Ex. S.*		*Cons. Ex. S.*		*Pums*		*Pums*	
N	*612*		*612*		*612*		*12711*		*12711*	
Variable Names	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.
Intercept	-1.78	-.66	1.78	1.40	1.98	1.30	-9.03	-23.2	-9.03	-23.2
Agehd	-.605	-.62	4.72	7.37	-2.67	-4.77	-	-	-	-
Aghdsq	.476	3.70	-.551	-6.47	.387	5.19	-.0002	-2.88	-.0002	-2.88
Inc	-1.64	-3.79	-3.28	-11.5	-.33	-1.34	.0593	7.52	.0593	7.52
Incsq	.132	6.28	.187	13.4	.043	3.6	-	-	-	-
Hsze	.728	20.3	-.042	-1.75	.145	6.92	2.498	24.3	2.498	24.3
Rx	2.22	11.9	.704	6.61	-	-	-	-	-	-
Hx	-1.31	-9.9	-	-	.374	5.58	-	-	-	-
Tx	-.891	-6.8	1.19	21.6	-.298	-3.92	-	-	-	-
Rent:mfd							-.0055	-13.2	-	-
Mfd							12.74	31.5	-	-
Mfd*hsze							-4.5	-35.4	-	-
Mfd*inc							-.227	-11.7	-	-
Mfd*agesq							.0004	3.28	-	-
Rentdiff:mfd							.01	-	-	-
Rent:sfa									-.0055	-13.2
Sfa									.70	6.57
Sfa*hsze									-.50	-18.5
Sfa*inc									-.0745	-6.85
Sfa*agesq									.0000	.026
Rentdiff:sfa									.005	-

Tables of Parameter Estimates:

Equation Number	7.)		8.)		9.)		10.)	
Dependent Variable	*rent:%sfd*		*own:%sfd*		*own:%sfa*		*own:%mfd*	
Estimation Method	*WRLS*		*WRLS*		*WRLS*		***WRLS***	
RSQ.	*.40*		*.87*		*.87*		*.87*	
Data Source	*Pums*		*Pums*		*Pums*		*Pums*	
N	*12711*		*21569*		*21569*		*21569*	
Variable Names	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.
Intercept	-9.03	-23.2	10.92	48.51	10.92	48.51	10.92	48.51
Agehd	-	-	-	-	-	-	-	-
Aghdsq	-.0002	-2.88	-.0004	-9.76	-.0004	-9.76	-.0004	-9.76
Inc	.0593	7.52	.0265	10.66	.0265	10.66	.0265	10.66
Incsq	-	-	-	-	-	-	-	-
Hsze	2.498	24.3	.726	15.43	.726	15.43	.726	15.43
Rx	-	-	-	-	-	-	-	-
Hx	-	-	-	-	-	-	-	-
Tx	-	-	-	-	-	-	-	-
Rent:sfd	-.0055	-13.2	-	-		-		-
Hprc:sfd			-.0155	-25.8				
Hprc:mfd							-.0155	-25.8
Mfd							-3.22	-79.6
Mfd*hsze							-1.22	-18.5
Mfd*inc							-.054	-16.1
Mfd*agesq							.0007	13.22
Prcdiff:mfd							.030	-
Hprc:sfa					-.0155	-25.8		
Sfa					-2.92	-80.8		
Sfa*hsze					-1.07	-16.2		
Sfa*inc					-.03	-8.86		
Sfa*agesq					.0007	12.93		
Prcdiff:sfa					.015	-		

Tables of Parameter Estimates:

Equation Number	11.)		12.)		13.)		14.)	
Dependent Variable	*ownsze*		*rentsze*		*nvehls*		*nearns*	
Estimation Method	*WLS*		*WLS*		*WLS*		***WLS***	
RSQ.	*.59*		*.64*		*.89*		*.91*	
Data Source	*AHS*		*Pums*		*Cons. Exp. S.*		*Cons. Exp. S.*	
N	*206*		*200*		*612*		*612*	
Variable Names	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.
Intercept	14.594	8.16	-.122	-.07	-18.55	-15.5	-30.9	-18.6
Agehd	-	-	-	-	.453	1.05	9.85	16.06
Aghdsq	-	-	-	-	-.028	-.485	-1.41	-17.33
Inc	-1.79	-5.03	.055	.157	3.05	15.9	2.327	8.62
Incsq	.104	5.85	-.0031	-.169	-.13	-13.9	-.0953	-7.26
Hsze	.261	6.14	.64	18.41	.390	24.48	.494	21.52
Rx	-	-	-.191	-1.63	.968	11.7	-	-
Hx	-.096	-1.35	-	-	-.218	-3.69	-	-
Tx	-	-	-	-	-.728	-12.5	-.253	-5.62

Tables of Parameter Estimates:

Equation Number	15.)		16.)		17.)		18.)		19.)	
Dependent Variable	*food*		*house*		*trans*		*health*		*other*	
Estimation Method	*RSUR*		*RSUR*		*RSUR*		***RSUR***		*RSUR*	
RSQ.	*.94*		*.96*		*.89*		*.86*		*.97*	
Data Source	*Cons. Ex. S.*		*Cons. Ex. S.*		*Cons. Ex. S.*		*Cons. Ex. S.*		*Cons. Ex. S.*	
N	*612*		*612*		*612*		*612*		*612*	
Variable Names	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.	Coef. Est.	T Val.
Intercept	6.77	9.9	6.24	10.5	-2.88	-2.2	-6.85	-4.2	3.8	4.4
Agehd	1.02	4.51	3.30	16.8	-.155	-.36	-1.08	2.05	2.36	8.4
Aghdsq	-.12	-3.92	-.443	-16.7	-.005	-.09	.327	-4.6	-.332	-8.8
Inc	-.51	-4.4	-1.12	-11.1	1.73	7.7	2.06	7.5	-.65	-4.5
Incsq	.042	7.36	.078	15.9	-.055	-5.05	-.08	-6.02	.072	9.9
Hsze	.415	43.2	.102	12.3	.212	11.5	.22	9.8	.041	3.4
Fdx	-1.72	-1.41	-	-	-	-	-	-	-	-
Hrx	-	-	-.027	-.40	-	-	-	-	-	-
Tx	-	-	-	-	.405	6.05	-	-	-	-
Hlx	-	-	-	-	-	-	4.05	3.29	-	-
Otx	-	-	-	-	-	-	-	-	-9.39	-3.11
Fdxhrx	2.71	2.54	2.71	2.54	-	-	-	-	-	-
Fdxtx	-2.97	-2.84	-	-	-2.97	-2.84	-	-	-	-
Fdxhlx	10.2	1.63	-	-	-	-	10.2	1.63	-	-
Fdxotx	-.54	-.048	-	-	-	-	-	-	-.54	-.048
Hrxtx	-		-.147	-4.02	-.147	-4.02	-	-	-	-
Hrxhlx	-		.681	2.81	-	-	.681	2.81	-	-
Hrxotx	-		-1.95	-4.38	-	-	-	-	-1.95	-4.38
Txhlx	-		-	-	-1.32	-6.19	-1.32	-6.19	-	-
Txotx	-		-	-	2.31	5.87	-	-	2.31	5.87
Hlxotx	-		-	-	-	-	17.15	3.32	17.15	3.32

Tables of Parameter Estimates:

Equation Number	**51.)**		**51a.)**	
Dependent Variable	*hseloc:own*		*hseloc:rent*	
Estimation Method	*WLS*		*WLS*	
RSQ.	*.25*		*.28*	
Data Source	*Pums*		*Pums*	
N	*21882*		*13916*	
Variable Names	Coef. Est.	T Val.	Coef. Est.	T Val.
Intercept	-2.164	-5.48	2.407	4.95
Inc	-.032	-6.02	-.115	-11.2
Inc*travelmin	-.00012	-1.04	.00045	2.4
Neighdx*inc	.00018	7.25	.00006	4.46
Nearns	.7904	3.8	.1809	.70
Nearns*travelmin	.0272	5.29	-.0097	-1.51
Prcequilmultiplier	-.03748	-15.6	-.00984	-11.9
Neighdx*travelmin	.00019	4.41	.000053	3.06
Travelmin	-.0265	-1.47	-.085	-3.76
Travelminsq	-.00194	-13.08	-.00114	-5.92
Hseopp	-4.405	-9.21	-2.893	-4.86

Appendix E: Non-Residential Model Equations and Parameter Estimates

Demand Equations:

$$DSqFt_{i,k,j} = [TotalEmp]_i [Percent_o]_{i,k} [SqFtEmp_o]_{i,k} [\Pr ice]_{j,ko}^{-\beta_{i,k}} \{\sum_{k \neq ko}^{5} [\Pr ice]_{j,k}^{+\beta_{i,k}}\} [\Pr ice]_{j,k}^{-\gamma_{i,k}} [\Pr ice]_{j,k}^{-\alpha_{j,k}}$$

$$\{A_{1,i}(AllEmpAcs)_i + A_{2,i}(SameEmpAcs)_i + A_{3,i}(AllHhAcs)_i\}$$

Subject to: $\beta_{1,2,i} = \beta_{2,1,i} ... \beta_{mn,i} = \beta_{nm,i}$; $\sum_m \beta_k \sum_n \beta_k = 0$

and: $A_{1,i} + A_{2,i} + A_{3,i} = 1$

$$AllEmpAcs_i = \frac{\sum_{j=1}^{20} (AllEmp_l / acres_l)(B_{1,i}Time_{jl} + B_{2,i}Time_{jl}^2)^{-1}}{\sum_{l=1}^{20}\sum_{j=1}^{20} (AllEmp_l / acres_l)(B_{1,i}Time_{jl} + B_{2,i}Time_{jl}^2)^{-1}}$$

$$SameEmpAcs_i = \frac{\sum_{j=1}^{20} (SameEmp_l / acres_l)(B_{1,i}Time_{jl} + B_{2,i}Time_{jl}^2)^{-1}}{\sum_{l=1}^{20}\sum_{j=1}^{20} (SameEmp_l / acres_l)(B_{1,i}Time_{jl} + B_{2,i}Time_{jl}^2)^{-1}}$$

$$AllHhAcs_i = \frac{\sum_{j=1}^{20} (AllHh_l / acres_l)(B_{1,i}Time_{jl} + B_{2,i}Time_{jl}^2)^{-1}}{\sum_{l=1}^{20}\sum_{j=1}^{20} (AllHh_l / acres_l)(B_{1,i}Time_{jl} + B_{2,i}Time_{jl}^2)^{-1}}$$

$$Emp_{i,k,j} = \frac{DSqFt_{i,k,j}}{(SqFtEmp_o)(\Pr ice)_{k,j}^{-\gamma_{i,k}}}$$

Supply Equations:

$$SupSqFt_{i,k,j} = \sum_{n=} (acres_{j,k,n})(F.A.R.)_{k,n}$$

Subject to: $(SqFt\Pr ice)_{j,k,n} \geq (SqFtCost)_{j,k,n}$

$$SqFt\Pr ice_{j,k,n} = (SqFt\Pr ice_o)_{j,k,n}(\Pr ice)_{j,k}$$

$$SqFtCost_{j,k,n} = (SqFtLandCost)_{j,k,n} + (SqFtCapitalCost)_{j,k,n}$$

$$SqFtLandCost_{j,k,n} = +f[(\Pr ice)_{j,k} : (SqFtLandCost_o)_{j,k,n} : \sigma_k]$$

$$SqFtLand_{j,k,n} = -f[(\Pr ice)_{j,k} : (SqFtLand_o)_{j,k,n} : \sigma_k]$$
$$F.A.R._{j,k,n} = (SqFtCapital_o)_{k,n} / SqFtLand_{j,k,n}$$
$$SqFtCapitalCost_{k,n} = +f[K_{o,k} + K_{1,k}(F.A.R.)_{k,n}]$$

Subject to: $(SqFtCapital_o)_{k,n} \big/ SqFtLand_{j,k,n} \le MaxF.A.R._{j,k,n}$

Equation System Solution:

Find: $\Pr ice_{j,k}$

Such that: $\sum_i \sum_j \sum_k DSqFt_{i,k,j} - \sum_i \sum_j \sum_k SupSqFt_{i,k,j} = Min.$

Definitions:

$DSqFt_{i,k,j}$: Demand in square feet for nonresidential real estate type k by industry type i in zone j.

$TotalEmp_i$: Total regional employment in industry type i.

$[Percent_o]_{i,k}$: Percentage of employment in industry type i that chooses real estate type k when the price ratio is set at one.

$[SqFtEmp_o]_{i,k}$: Square feet per employee required by industry i in real estate type k when the price ratio is set at one.

$\Pr ice_{j,k}$: The price ratio in zone j for real estate type k

$\beta_{i,k}$: The cross price elasticity of industry type i for real estate type k. Cross price elasticities allow the substitution by industry of one real estate type for another as a function of their relative price ratios. We apply the usual cross price elasticity restrictions in that they be symmetrical and sum to zero.

$\gamma_{i,k}$: The square feet per employee consumption price elasticities by industry type i for real estate type k.

$\alpha_{j,k}$: The location choice price elasticities by zone j for real estate type k

$AllEmpAcs_i$: Measure of the access of industry type i in zone j to total employment within the region.

$SameEmpAcs_i$: Measure of the access of industry type i in zone j to the same industry type employment within the region

$AllHhAcs_i$: Measure of the access of industry type i in zone j to all households within the region

$A_{1,i}, A_{2,i}, A_{3,i}$: Share each access measure contributes to the "attractiveness" of zone j to industry i.

$AllEmp_l$: Total employment in one of 20 zones j (l is arbitrary counter for 20 zones located at various travel times from zone j.)

$Acres_l$: Acres of total developed nonresidential land in each of 20 zones j (l is arbitrary counter for 20 zones located at various travel times from zone j.)

$Time_{j,l}$: Travel time in minutes from zone j (for which access is being measured) to each of 20 zones l.

$SameEmp_l$: Employment in the same industry type in one of 20 zones for which access is being measured. (l is arbitrary counter for 20 zones located at various travel times from zone j.)

$AllHh_l$: All households in one of 20 zones for which access is being measured. (l is arbitrary counter.)

$B_{1,i}, B_{2,i}$: Estimated coefficients measuring the importance of travel time to employment and households for each industry type i.

$SupSqFt_{i,k,j}$: Supply in square feet of real estate type k for industry type i in zone j

$Acres_{j,k,n}$: Acres of available nonresidential land in zone j, designated for real estate type k in floor-to-area ratio(F.A.R.) regulatory class n

$F.A.R._{k,n}$: Computed actual floor-to-area-ratio for industry type k in regulatory class n in zone j.

$SqFt\,Price_{j,k,n}$: Market price for real estate type k in zone j for F.A.R. regulatory class n.

$SqFtCost_{j,k,n}$: Cost to suppliers to construct real estate of type k for F.A.R. regulatory class n in zone j.

$SqFtLandCost_{j,k,n}$: Cost per sq. foot to supply "ready-to-build" land in zone j for real estate type k for F.A.R. regulatory class n.

$(SqFtLandCost_o)_{j,k,n}$: Base cost per sq. foot to supply "ready-to-build" land when all price ratios are set to 1.

σ_k : Capital – land substitution parameter for real estate type k with respect to $Price_{j,k}$

$SqFtLand_{j,k,n}$: The percent share of land required for each unit of capital produced for zone j, real estate type k and F.A.R. regulatory class n.

$(SqFtLand_o)_{j,k,n}$: The base share of land required for each unit of capital produced for zone j, real estate type k and F.A.R. regulatory class n when price ratios are set to 1.

$(SqFtCapital_o)_{k,n}$: The base share of capital for real estate type k in F.A.R. regulatory class n when the price ratios are set to 1.

$SqFtCapitalCost_{k,n}$: Cost per square foot for capital for real estate type k in F.A.R. regulatory class n

$K_{o,k}, K_{1,k}$: Constants on a function that relate capital costs per square foot to floor-to-area ratio by real estate type k.

$MaxF.A.R.$: The maximum floor-to-area ratio allowable under the regulations in zone j, for real estate type k for F.A.R. regulatory class n.

Estimated Parameters for the Non-Residential Model

PercentSubZero Parameters			**Real Estate Type (k)**			
Industry (i)	Manufacturing	Warehousing	Retail/Services	General Office	Medical/Health	Government
Agriculture,timber	0.2216	0.2408	0.0110	0.5070	0.0100	0.0096
Construction	0.5400	0.1851	0.0839	0.1321	0.0000	0.0588
Nondurable manufacturing	0.9065	0.0000	0.0002	0.0749	0.0144	0.0040
Durable man.,metals, paper	0.8367	0.0748	0.0084	0.0797	0.0004	0.0000
High tech manufacturing	0.8588	0.0549	0.0006	0.0703	0.0154	0.0000
Transport and warehousing	0.3130	0.4624	0.1661	0.0467	0.0031	0.0088
Communications and utilities	0.1155	0.0361	0.1387	0.6745	0.0225	0.0126
Wholesale trade	0.3130	0.4624	0.1661	0.0467	0.0031	0.0088
Retail trade	0.1747	0.0001	0.7286	0.0810	0.0111	0.0046
Finance, insurance, real estate	0.1155	0.0361	0.1387	0.6745	0.0225	0.0126
Consumer services	0.1528	0.0087	0.4423	0.3354	0.0107	0.0501
Health services	0.1678	0.0000	0.0053	0.1115	0.6478	0.0675
Business, professional services	0.0229	0.0000	0.1480	0.6467	0.1727	0.0097
Government	0.0248	0.0000	0.0311	0.1896	0.0155	0.7389

SqFtEmpSubZero Parameters			**Real Estate Type (k)**			
Industry (i)	Manufacturing	Warehousing	Retail/Services	General Office	Medical/Health	Government
Agriculture,timber	540.0	1125.0	405.0	405.0	405.0	405.0
Construction	80.0	320.0	80.0	80.0	80.0	80.0
Nondurable manufacturing	630.0	720.0	405.0	315.0	315.0	315.0
Durable man.,metals, paper	585.0	675.0	405.0	315.0	315.0	315.0
High tech manufacturing	360.0	540.0	405.0	315.0	315.0	315.0
Transport and warehousing	680.0	2805.0	425.0	382.5	382.5	382.5
Communications and utilities	340.0	680.0	510.0	297.5	382.5	382.5
Wholesale trade	280.0	980.0	350.0	315.0	315.0	315.0
Retail trade	260.0	390.0	227.5	227.5	227.5	227.5
Finance, insurance, real estate	280.0	420.0	420.0	245.0	245.0	315.0
Consumer services	260.0	390.0	227.5	227.5	227.5	227.5
Health services	340.0	510.0	510.0	297.5	297.5	382.5
Business, professional services	300.0	450.0	337.5	262.5	262.5	262.5
Government	540.0	720.0	405.0	315.0	315.0	540.0

Gamma Parameters						
Industry (i)	Manufacturing	Warehousing	Retail/Services	General Office	Medical/Health	Government
Agriculture,timber	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000
Construction	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000
Nondurable manufacturing	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000	-0.1000
Durable man.,metals, paper	-0.1000	-0.1000	-0.0500	-0.0500	-0.0500	-0.0500
High tech manufacturing	-0.1000	-0.1000	-0.0500	-0.0500	-0.0500	-0.0500
Transport and warehousing	-0.1000	-0.1000	-0.1000	-0.1000	-0.0500	-0.0500
Communications and utilities	-0.0500	-0.0500	-0.1000	-0.0500	-0.0500	-0.0500
Wholesale trade	-0.0500	-0.1000	-0.2000	-0.1000	-0.1000	-0.1000
Retail trade	-0.1000	-0.1000	-0.1000	-0.0500	-0.0500	-0.0500
Finance, insurance, real estate	-0.0500	-0.1000	-0.1500	-0.1000	-0.0500	-0.0500
Consumer services	-0.0500	-0.0500	-0.0500	-0.1000	-0.1000	-0.1000
Health services	-0.0500	-0.0500	-0.0500	-0.1000	-0.1000	-0.1000
Business, professional services	-0.0500	-0.0500	-0.0500	-0.0500	-0.0500	-0.0500
Government	-0.0500	-0.0500	-0.0500	-0.0500	-0.0500	-0.0500

Beta parameters		Real Estate Type (k)					
Industry (i)	**Real Estate Type (k)**	Manufacturing	Warehousing	Retail/Services	General Office	Medical/Health	Government
Agriculture,timber	Manufacturing	-0.5500	0.3000	0.0500	0.1000	0.0500	0.0100
Agriculture,timber	Warehousing	0.3000	-0.5500	0.0500	0.1000	0.0500	0.0100
Agriculture,timber	Retail/Services	0.0500	0.0500	-0.2500	0.0500	0.0500	0.0100
Agriculture,timber	General Office	0.1000	0.1000	0.0500	-0.3500	0.0500	0.0100
Agriculture,timber	Medical/Health	0.0500	0.0500	0.0500	0.0500	-0.2500	0.0100
Agriculture,timber	Government	0.0100	0.0100	0.0100	0.0100	0.0100	-0.0500
Construction	Manufacturing	-0.4200	0.2000	0.1000	0.1000	0.0100	0.0100
Construction	Warehousing	0.2000	-0.4200	0.1000	0.1000	0.0100	0.0100
Construction	Retail/Services	0.1000	0.1000	-0.3200	0.1000	0.0100	0.0100
Construction	General Office	0.1000	0.1000	0.1000	-0.3200	0.0100	0.0100
Construction	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0100
Construction	Government	0.0100	0.0100	0.0100	0.0100	0.0100	-0.0500
Nondurable manufacturing	Manufacturing	-0.3300	0.2000	0.0100	0.1000	0.0100	0.0000
Nondurable manufacturing	Warehousing	0.2000	-0.3300	0.0100	0.1000	0.0100	0.0000
Nondurable manufacturing	Retail/Services	0.0100	0.0100	-0.0500	0.0100	0.0100	0.0000
Nondurable manufacturing	General Office	0.1000	0.1000	0.0100	-0.2300	0.0100	0.0000
Nondurable manufacturing	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0000
Nondurable manufacturing	Government	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Durable man.,metals, paper	Manufacturing	-0.3300	0.2000	0.0100	0.1000	0.0100	0.0000
Durable man.,metals, paper	Warehousing	0.2000	-0.3300	0.0100	0.1000	0.0100	0.0000
Durable man.,metals, paper	Retail/Services	0.0100	0.0100	-0.0500	0.0100	0.0100	0.0000
Durable man.,metals, paper	General Office	0.1000	0.1000	0.0100	-0.2300	0.0100	0.0000
Durable man.,metals, paper	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0000
Durable man.,metals, paper	Government	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
High tech manufacturing	Manufacturing	-0.3200	0.1000	0.1000	0.1000	0.0100	0.0000
High tech manufacturing	Warehousing	0.1000	-0.3200	0.1000	0.1000	0.0100	0.0000
High tech manufacturing	Retail/Services	0.1000	0.1000	-0.3200	0.1000	0.0100	0.0000
High tech manufacturing	General Office	0.1000	0.1000	0.1000	-0.3200	0.0100	0.0000
High tech manufacturing	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0000
High tech manufacturing	Government	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Transport and warehousing	Manufacturing	-0.4300	0.3000	0.0100	0.1000	0.0100	0.0000
Transport and warehousing	Warehousing	0.3000	-0.4300	0.0100	0.1000	0.0100	0.0000
Transport and warehousing	Retail/Services	0.0100	0.0100	-0.0500	0.0100	0.0100	0.0000
Transport and warehousing	General Office	0.1000	0.1000	0.0100	-0.2300	0.0100	0.0000
Transport and warehousing	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0000
Transport and warehousing	Government	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Communications and utilities	Manufacturing	-0.1700	0.0500	0.0500	0.0500	0.0100	0.0100
Communications and utilities	Warehousing	0.0500	-0.1700	0.0500	0.0500	0.0100	0.0100
Communications and utilities	Retail/Services	0.0500	0.0500	-0.2200	0.1000	0.0100	0.0100
Communications and utilities	General Office	0.0500	0.0500	0.1000	-0.2200	0.0100	0.0100
Communications and utilities	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0100
Communications and utilities	Government	0.0100	0.0100	0.0100	0.0100	0.0100	-0.0500
Wholesale trade	Manufacturing	-0.4300	0.3000	0.0100	0.1000	0.0100	0.0000
Wholesale trade	Warehousing	0.3000	-0.4300	0.0100	0.1000	0.0100	0.0000
Wholesale trade	Retail/Services	0.0100	0.0100	-0.0500	0.0100	0.0100	0.0000
Wholesale trade	General Office	0.1000	0.1000	0.0100	-0.2300	0.0100	0.0000
Wholesale trade	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0000
Wholesale trade	Government	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Retail trade	Manufacturing	-0.0500	0.0100	0.0100	0.0100	0.0100	0.0100
Retail trade	Warehousing	0.0100	-0.2300	0.1000	0.1000	0.0100	0.0100
Retail trade	Retail/Services	0.0100	0.1000	-0.4300	0.3000	0.0100	0.0100
Retail trade	General Office	0.0100	0.1000	0.3000	-0.4300	0.0100	0.0100
Retail trade	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0100
Retail trade	Government	0.0100	0.0100	0.0100	0.0100	0.0100	-0.0500
Finance, insurance, real estate	Manufacturing	-0.1700	0.0500	0.0500	0.0500	0.0100	0.0100
Finance, insurance, real estate	Warehousing	0.0500	-0.1700	0.0500	0.0500	0.0100	0.0100
Finance, insurance, real estate	Retail/Services	0.0500	0.0500	-0.2200	0.1000	0.0100	0.0100
Finance, insurance, real estate	General Office	0.0500	0.0500	0.1000	-0.2200	0.0100	0.0100
Finance, insurance, real estate	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0100
Finance, insurance, real estate	Government	0.0100	0.0100	0.0100	0.0100	0.0100	-0.0500
Consumer services	Manufacturing	-0.0500	0.0100	0.0100	0.0100	0.0100	0.0100
Consumer services	Warehousing	0.0100	-0.2300	0.1000	0.1000	0.0100	0.0100
Consumer services	Retail/Services	0.0100	0.1000	-0.6300	0.5000	0.0100	0.0100
Consumer services	General Office	0.0100	0.1000	0.5000	-0.6300	0.0100	0.0100
Consumer services	Medical/Health	0.0100	0.0100	0.0100	0.0100	-0.0500	0.0100
Consumer services	Government	0.0100	0.0100	0.0100	0.0100	0.0100	-0.0500
Health services	Manufacturing	-0.0500	0.0100	0.0100	0.0100	0.0100	0.0100
Health services	Warehousing	0.0100	-0.0500	0.0100	0.0100	0.0100	0.0100

Alpha Parameters

Industry (i)	
Agriculture,timber	-0.3702
Construction	-1.1090
Nondurable manufacturing	-0.7494
Durable man.,metals, paper	-1.5073
High tech manufacturing	-1.0166
Transport and warehousing	-1.2369
Communications and utilities	-0.1096
Wholesale trade	-1.2346
Retail trade	-0.6656
Finance, insurance, real estate	-0.2098
Consumer services	-0.6401
Health services	-0.4811
Business, professional services	-0.3120
Government	-0.3766

A Parameters

Industry (i)	Same Industry	All Industry	All Households
Agriculture,timber	0.9030	0.0624	0.0346
Construction	0.4295	0.0000	0.5705
Nondurable manufacturing	0.8383	0.1229	0.0388
Durable man.,metals, paper	0.9587	0.0413	0.0000
High tech manufacturing	1.0000	0.0000	0.0000
Transport and warehousing	0.8459	0.1541	0.0000
Communications and utilities	0.8981	0.1019	0.0000
Wholesale trade	0.4718	0.5272	0.0010
Retail trade	0.5040	0.0000	0.4960
Finance, insurance, real estate	0.6364	0.2841	0.0794
Consumer services	0.9556	0.0000	0.0444
Health services	0.6509	0.0488	0.3003
Business, professional services	0.5575	0.4425	0.0000
Government	0.6067	0.1991	0.1942

B Parameters

Industry (i)	time	time squared
Agriculture,timber	0.0839	0.0344
Construction	0.0104	0.0608
Nondurable manufacturing	0.5891	0.5537
Durable man.,metals, paper	0.3438	0.3674
High tech manufacturing	-0.0174	0.0128
Transport and warehousing	-0.0027	0.0567
Communications and utilities	0.0352	0.0878
Wholesale trade	0.0290	0.0481
Retail trade	0.0209	0.1195
Finance, insurance, real estate	-0.0011	0.0989
Consumer services	0.6976	0.7430
Health services	0.0061	0.0382
Business, professional services	0.0638	0.1186
Government	-0.0114	0.0244
All Employment	0.1116	0.0432
All Households	-0.0131	0.0880

M E M O R A N D U M

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METRO

Date: March 28, 2001

To: Metropolitan Technical Advisory Committee

From: Brenda Bernards, Senior Regional Planner BB
Long-Range Planning Division

Re: 2040 Centers and Periodic Review

As part of the Periodic Review Program Metro is undertaking a review of the 2040 Centers. The task involves the evaluation of mixed-use areas (Centers, Station Communities and Main Streets) to determine if these areas have been underutilized in terms of achieving 2040 type densities and whether there could be additional regulation that could be put in place to increase capacity in these areas.

This work is essential to fulfill the Goal 14 requirement to evaluate whether there are additional efficiencies or areas that could receive more density as an alternative to expanding the Urban Growth Boundary (UGB). Findings from this study will raise policy issues such as whether it is acceptable to the region to increase densities in these areas, whether the UGB should be expanded or some combination of increased densities and expansion is necessary.

The 2040 Centers project will review the effectiveness of regional and local efforts to identify and remove the impediments to achieving vibrant centers and to ensure that the Centers become livable, transportation-efficient, pedestrian-friendly communities. 2040 zoning is in place but, while it is necessary, it clearly is not enough. This project will look at what else is required in order to begin the anticipated changes to the centers. This will include an examination of policies, regulations and plans in place, infrastructure needs and strategic tools to start the centers developing as envisioned in 2040 Growth Concept.

The product of this project will be the identification of strategies, roles, strategic tools and potential code changes for local jurisdictions and the region to go beyond design and zoning land to move the 2040 Centers from concept to reality.

The 2040 Centers project has a three phase work program.

Phase I involved a series of Interviews with local jurisdiction to identify opportunities for housing and employment capacity not included in the 2017 capacity calculations and to identify barriers to achieving capacity within the 2017 timeframe and beyond.

Interviews were held with local jurisdiction staff representing Beaverton, Clackamas County, Cornelius, Fairview, Forest Grove, Gladstone, Gresham, Happy Valley, Hillsboro, King City, Lake Oswego, Milwaukie, Oregon City, Portland, Sherwood, Tigard, Troutdale, Tualatin, Washington County and West Linn. The local staff was asked to address three issues:

Draft: March 29, 2001

PERIODIC REVIEW

TASK 1.6: EVALUATE MIXED-USE AREAS AND CORRIDORS FOR ADDITIONAL CAPACITY (GOAL 14)

Task 1.6 falls under Subtask 13 Land Supply Analysis of the Periodic Review Work Program Summary submitted to DLCD. The task involves the evaluation of mixed-use areas (Centers, Station Communities and Main Streets) and Corridors to determine if these areas have been underutilized in terms of achieving 2040 type densities and whether there could be additional regulation that could be put in place to increase capacity in these areas. This is a localized analysis of the many mixed use centers and corridors in the region. It will be an analysis based on local values.

This work is essential to fulfill the Goal 14 requirement to evaluate whether there are additional efficiencies or areas that could receive more density as an alternative to expanding the Urban Growth Boundary. Findings from this study will raise policy issues such as whether it is acceptable to the region to increase densities in these areas, whether the Urban Growth Boundary should be expanded or some combination of increased densities and expansion is necessary.

> *Goal 14: Urbanization*
>
> *To provide for an orderly and efficient transition from rural to urban land use.*
>
> *Urban growth boundaries shall be established to identify and separate urbanizable land from rural land. Establishment and change of the boundaries shall be based upon considerations of the following factors:*
>
> *(4) Maximum efficiency of land uses within and on the fringe of the existing urban area;*

Work Program – Draft for Discussion

The work program will be conducted in three phases.

Phase I

<u>1. Examination of local capacity</u>

Local jurisdiction staff will be interviewed to identify additional opportunities for increasing capacity in all design types areas, but with an emphasis on mixed use areas.

a. identification of housing and employment capacity not included in the 2017 capacity calculations;
b. identification of barriers to achieving capacity within the 2017 timeframe and beyond; and
c. review of the 2040 Analysis maps for accuracy.

4. Identification of Opportunities and Constraints to achieving 2040 Centers

The interviews of local jurisdiction staff in Phase I identified the opportunities and constraints to building compact, mixed-use centers in designated areas. The preliminary identification indicated that the most significant constraint is that the zoned capacity of the 2040 Centers is ahead of the market. For the most part, any development that is occurring is happening at the minimum zoning. The consultant would investigate what are the reasons the development is not occurring at the desired densities. In addition, the consultant would develop strategies for building on the opportunities identified by the local jurisdictions.

a. Review the opportunities and constraints identified in Phase I
b. Identify further opportunities and constraints for developing 2040 Centers
a. Examination of local strategic tools.
b. Assessment of the effectiveness of the strategic tools in place.
c. Develop strategies for overcoming the obstacles to achieving development
d. Develop strategies for building on the opportunities

Product: A draft report outlining a series of strategies to build on opportunities and to overcome obstacles to achieve 2040 Centers.

5. Development of Policy Recommendations

a. Based on findings of the Project, the consultant will make policy and regulatory recommendations.

Product: Final report outlining a series of strategies to build on opportunities and to overcome obstacles to achieve 2040 Centers. Based on findings of this work, policy and regulatory recommendations will be made which will provide direction to Metro's Urban Growth Boundary – Regional Framework Plan decisions in 2002.

Task 1	March – April 2001
Task 2	April – June 2001
Task 3	May – July 2001
Task 4,5	May – June 2001

Phase III

1. Incorporate Findings of Phase I and II into Periodic Review Program

a. policy modifications
b. identification of barriers – determination of actions to remedy
c. possible development of new policy

Product: Identification of policy issues including:

a. whether it is acceptable to the region to increase densities in the 2040 Centers;
b. amending the Urban Growth Boundary in order to support 2040 Centers; and
c. amending policies to support the 2040 Centers.

Time Line for Phase III
February 2002

\\alex\work\gm\community_development\projects\2040 Centers\Work Program draft.doc

Miscellaneous

DATE: March 19, 2001

TO: Metro Technical Advisory Committee

FROM: Mary Weber, Manager
Community Planning

RE: ***METRO PERIODIC REVIEW – WORK PROGRAM APPROACH TO ASSESSING METRO POLICY OPTIONS FOR PROVIDING LAND TO MEET FUTURE EMPLOYMENT NEEDS – WITH MPAC COMMENTS***

Background

MPAC added several issues and work tasks to this research element. The committee recommendations are written in ***bold italic and underlined***.

Listed below is a series of questions on how to accommodate future job growth.

- Among the different types of companies/industries that make up the region's economy, some industry's land and location needs are very specific while others are flexible and more general in their requirements. Should Metro assume that a wider range of jobs and greater number of jobs might be accommodated in 2040 mixed-use centers?

- Should the region's growth management policies continue to support the expansion of land intensive industrial uses through targeted UGB amendments, i.e., do we need to provide for large lot industrial sites?

- Several sectors of the regional economy, specifically warehousing and transportation are forecasted to experience continued growth. However, nationally, these same industries show decline in the overall share of employment. Should Metro assume continued growth and provide land to accommodate these industries? Or should Metro take no action in providing expansion sites as part of UGB amendments thereby reducing the likelihood of expansion of these industries in this region?

- The forecast assumptions call for a slight increase in employment density. Is a more aggressive goal feasible or desirable?

- Are there employment sectors of the economy that the region should be pursuing? If yes, should the region's growth management policies support this effort through UGB amendments to meet that sectors land needs?

- ***Are there sufficient limits on non-industrial uses in zoned industrial areas to conserve the land supply for industrial users with restricted location and site needs?***

- ***Should Metro discourage the siting of warehousing uses in the Portland metropolitan area, thereby encouraging its development in more rural areas of the state?***

- ***Are there opportunities to accommodate industrial users, which require large sites, in areas which are created through assemblage of smaller lots and recovery of brownfields? What opportunities for parcel assemblage exist in the region?***

- ***Does local permit home based business?***

- ***To what degree should economic development policies be regionalized and what is the relationship between regional policies and a local government's ability to provide services?***

- ***Does the amount of urban growth boundary expansion undermine the region's redevelopment goals and how does expansion impact local tax base?***

Approach

Because of the limited time available to Metro to complete its Periodic Review work program by the end of 2002, staff recommends that the employment research activity focus on compiling and analyzing existing data and studies. Supplementing this existing data, staff recommends interviewing local business development staff, professional site selectors and CEO's about the land needs of various types of firms and about the needs of local firms. This work will be completed by the end of May 2001.

I. **Metro Coordination with Ongoing Studies**

Metro will monitor and participate in the following ongoing studies that address land supply needs and future development opportunities.

- Regional Industrial Land Study (RILS) – Phase 3
- Damascus Economic and Employment Site Study – Clackamas County

Product: Coordination and inclusion of data in synthesis report.

II. **Synthesis of Existing Local Studies and Information**

Local jurisdictions and economic development organizations have commission study regarding future job growth in their area. Staff will gather the existing studies (five years or newer) and provide a synthesis of the research relating to job growth and land need.

- Regional Connections – Industry Clusters in the Metropolitan Portland Economy
- RILS Study – Phase 1 & 2
- Local Analysis Regarding Employment/Goal 9
  - Gresham
  - Beaverton
  - Portland – PDC
  - Hillsboro
  - Port of Portland
  - Clark County

Product: Synthesis report.

III. **Literature Search**

Conduct a literature search regarding the growth potential of these industries in the metro area and their location, land needs and their potential of siting on redevelopment sites.

- Change in warehousing and logistics industry (i.e., just in time, etc.)
- Growth of home-based jobs, self-employment and telecommuting

- Creative services
- Biotech
- Software and Internet development firms
- Scientific equipment manufacturing
- Film production industry

Product: Summary memorandum of the location, land needs and growth potential of these industries and potential of locating on redevelopment sites.

IV. *Review of local codes*

Conduct a review of local zoning codes to identify restrictions on home based business and non-industrial uses in industrial areas.

Product: A memorandum summarizing the findings.

V. Interviews

Key interviews with local site selectors, economic development staff and CEOs will provide a very practical look at where industries to choose to locate and the needs of existing firms. Ten to twelve interviews would be conducted. Metro staff would conduct the interviews. Staff could work with MTAC/MPAC to develop a short series of questions.

Product: Summary memorandum of the comments.

VI. Discussion/Examination of Local vs. Regional Roles

Include in this research is discussion paper of the various public sector roles and tools relating to job retention and growth in the region. The roles and tools to be examined include:

State role and tools – business retention activities, infrastructure loans to municipalities, business loans, enterprise zones and the Strategic Investment Program (SIP)

Local role and tools – business retention and recruitment activities, land assemblage, property tax abatement, tax increment financing for infrastructure (or land) within urban renewal districts, loans or grants for infrastructure and business loans/grants/job training

Metro role – land supply and functional plan requirements

Product: Memorandum regarding past roles/tools and potential new roles/tools.

VII. Provide Policy Options to Metro Council

Staff will draft Regional Framework Plan and Functional Plan policy options for discussion.

Product: Memorandum outline general policy options regarding UGB expansion, infill and redevelopment and regional capture rate for jobs.

Jobs-Housing Balance Revisited

Trends and Impacts in the San Francisco Bay Area

Robert Cervero

Regions in California have recently set jobs-housing balance targets, to relieve traffic congestion and improve air quality. Critics of such targets charge that many factors prevent people from living near their workplaces, and that market forces, left unobstructed, work to produce balance—that is, people and firms co-locate to reduce imbalances. This article examines changes in the ratios of jobs to employed residents in 23 large San Francisco Bay Area cities during the 1980s. Imbalances were found to have declined generally, mainly because dormitory communities in 1980 had attracted businesses by 1990. However, imbalances generally worsened in job-plus cities, particularly in the Silicon Valley. The research also reveals little association between jobs-housing balance and self-containment. Several Bay Area cities are nearly perfectly balanced, yet fewer than a third of their workers reside locally, and even smaller shares of residents work locally. Restricted housing production, especially in fast-growing cities, has in many instances raised housing prices, displacing workers and increasing average commute distances. Eliminating barriers to residential mobility and housing production would allow more housing and jobs to co-locate in the future.

Cervero is a professor of city planning at the University of California at Berkeley. His most recent research has been on the market potential of transit-oriented development, regional growth trends and their transportation impacts, and policies for stimulating paratransit services. He is also the author of two recent books, *Paratransit in America* (Praeger, 1996) and *Transit Villages for the 21st Century* (McGraw-Hill, 1996).

Journal of the American Planning Association, Vol. 62, No. 4, Autumn 1996.

In a 1989 *JAPA* article, I proposed jobs-housing balance as a strategy for reducing peak-period traffic congestion and air pollution in American cities. No one really disputes the proposition that having more people closer to their jobs will reduce vehicle miles traveled (VMT), freeway traffic, and tailpipe emissions. Whether jobs-housing balance is achievable, and if so, whether planning interventions or market forces are best suited for bringing about that balance, however, are still hotly debated.

In the 1980s, California's two largest metropolitan areas sought to set subregional targets for jobs-housing balance. The Association of Bay Area Governments (ABAG 1985) studied the potential for balancing employment and housing growth along the Interstate 580 and 680 corridors in the East Bay suburbs, a stretch where several dozen large-scale office parks and job centers were built and traffic congestion worsened during the 1980s. ABAG planners argued for managing growth along the corridor in combination with phased infrastructure investments; however, because of mounting political opposition, specific targets for jobs-housing balance were never adopted. In Southern California, two regional plans adopted in the late 1980s called for balanced growth as a strategy for relieving traffic congestion and improving air quality. The Southern California Association of Governments (SCAG 1989) and South Coast Air Quality Management Districts (1989) both adopted regional plans that redirected 9 percent of anticipated job growth from 1990 to 2010 to "housing-rich" areas and 5 percent of anticipated new housing to "jobs-rich" areas. Goals for jobs-housing balance were set for 22 subregions within the metropolitan area. SCAG devised an 18-step algorithm for evaluating whether proposed real estate projects should add dwelling units or employment in order to support the regional targets (Hamilton et al. 1991). Today, however, because of growing skepticism over the potential effectiveness of policies aimed at jobs-housing balance, SCAG has all but abandoned any enforcement of targets. More recently, the Southern California region has turned toward market-based strategies, such as cashing out free parking (Shoup 1995), tradeable permits (California Air Resources Board 1992; Orski 1995), and vehicle scrappage programs (Bae 1993), to reduce air pollution and traffic congestion.

Jobs-housing balance is the central issue in a legal battle currently being waged in Baltimore County, Maryland over whether to rezone 215 acres of prime real estate near the Hunt Valley employment center from a rural-conservation to a medium-density residential designation. Developers want to build some 1,500 townhouses and garden apartments on the site and have filed a lawsuit charging that the denial of a previous rezoning request has precluded Hunt Valley from becoming more balanced, something which the County's 1989–2000 Master Plan explicitly calls for. With currently three jobs for every housing unit within a fifteen-minute commute of Hunt Valley, proponents of the project are arguing that more jobs-housing balance would prevent traffic congestion from materially worsening along the I-680 beltway that rings Baltimore city.

One North American city where planning interventions that improved the jobs-housing balance have yielded demonstrable transportation benefits is Toronto. Nowlan and Stewart (1991) show that serious traffic problems were averted in Toronto's central core despite an office building boom in the 1970s and 1980s, through accelerated downtown housing construction. The authors found that most new housing there was occupied by downtown workers, many of whom could walk or conveniently ride mass transit to their jobs.

Giuliano (1991, 1995) and Downs (1992) question whether jobs-housing balance will ever be an effective tool for producing significant transportation and air quality benefits, citing several reasons: workers in two-earner households usually work in different locations; frequent job turnover reduces the ability to locate with reference to one's workplace; residential mobility continues to be hindered by exclusionary zoning policies and housing discrimination; and factors other than job access, such as quality of schools, are increasingly influencing residential location choices. Richardson and Gordon (1989) further argue that jobs-housing balance will have little effect on the fastest growing travel segment, the nonwork trip (which already accounts for three-quarters of all trips in the United States and the majority of trips during peak hours). While he maintains that the potential transportation and environmental pay-offs of jobs-housing balance are likely to be minimal, Downs (1992) notes that such policies may well be worth pursuing for other reasons, such as increasing socioeconomic and cultural diversity in American suburbs.

Regardless of whether planning interventions are warranted or potentially effective, Lowry (1988), Gordon, Richardson, and Jun (1991), Downs (1992), and others maintain that they are not needed, since regional balance is a natural evolutionary process brought on by market conditions. Over time, they argue, jobs and housing co-locate so as to maintain an equilibrium in average commuting times, as is consistent with time budget theory.[1] An example of co-location, according to Gordon et al. (1991), was the migration of jobs to the suburbs during the past two decades, resulting in polycentric urban structures that reduced commuting times. Using data from the 1980 census and the 1985 Annual Housing Survey, they found that average commuting times fell for 18 of the 20 largest United States metropolitan areas during the first half of the 1980s. Wachs et al. (1993) recently traced changes in journeys-to-work for over 8,000 hospital workers in Southern California, finding that the average commute times remained fairly constant and that average commute distances actually decreased slightly, from 10.0 miles in 1984 to 9.7 miles in 1990. Giuliano (1991) contends that imbalances usually erode over time, noting that Orange County, California was gradually transformed over the post-war era from a predominantly bedroom county to a more balanced subregion, with the ratio of jobs to population increasing from 0.21 in 1950 to 0.46 in 1985. More recently, Levinson and Kumar (1994) have shown that while traffic congestion and commuting distances are rising in the greater Washington, DC metropolitan areas, commuting durations are holding steady.

Other data, however, paint a much different portrait of recent commuting trends. According to the National Personal Transportation Survey (NPTS), the average commute length in the United States increased from 9.2 miles in 1983 to 10.6 miles in 1990 (Hu and Young 1992), which Bookout (1992, 10) notes is "an even poorer relationship between jobs and housing than experts expected to find."[2] Total vehicle miles traveled (VMT) increased by 55 percent, compared to an increase in population of only 12 percent for the same period. Longer-distance trips accounted for 38 percent of the growth in VMT. The share of metropolitan workers who worked in a different county from where they lived increased from 21 percent in 1980 to 24 percent in 1990.[3] In the San Francisco Bay Area, the share of employed residents of Solano County, the region's fastest-growing county, who commuted to a different county rose from 11.8 percent in 1960 to 38.6 percent in 1990 (Purvis 1992). And in contrast to the findings of Gordon et al. (1991), Rosetti and Eversole (1993), drawing on census data, show that mean commute times increased from 1980 to 1990 in 35 of the 39 metropolitan areas with 1990 populations over one million. The greatest increases were in metropolitan San Diego (19.5 to 22.2 minutes: +13.7 percent), Orlando (20.3 to 22.9 minutes: +12.7 percent), Los Angeles-Long Beach (23.6 to 26.4 minutes: +11.9 percent), and Sacramento (19.5 to 21.8 minutes: +11.8 percent).[4] Nationwide, average commute times increased more modestly (by only 40 seconds) during the 1980s, from 21.7 to 22.4 minutes.

Moreover, for every study showing that jobs-housing balance does not matter, there are at least as many that show it does. In a study of 1989 travel in the greater Seattle-Tacoma region, Frank and Pivo (1994) found that travel distances and times tended to be shorter for commutes to balanced areas. The average distance of work trips ending in balanced census tracts (with jobs-to-households ratios of 0.8 to 1.2) was 29 percent shorter (6.9 versus 9.6 miles) than the distance of trips ending in unbalanced tracts. A study by Ewing (1995), "Before We Write Off Jobs-Housing Balance . . . ," used 1990 census data to compute the proportion of work trips that remain within more than 500 cities and towns in Florida. From a regression analysis, Ewing found that the share of "internal," within-community, commutes significantly increased with greater balance between the numbers of local jobs and of working residents.

In light of the conflicting evidence on trends in commuting distances, and given the controversy that has erupted over jobs-housing balance as a policy tool, it is instructive to investigate trends in jobs-housing balance during the "turbulent" 1980s, a decade of rapid employment decentralization, worsening traffic congestion, and deteriorating air quality in many regions. This article conducts such an analysis, using 1980 and 1990 data on jobs-to-residents ratios and levels of self-containment for the largest cities in the San Francisco Bay Area. Whether cities have naturally evolved into more balanced and self-contained places, and the implications for commuting, are examined. The research also explores whether there were patterns in the kinds of cities that became more balanced during the 1980s or less balanced—for example, bedroom communities or job-surplus communities. Additionally, the effects of jobs-housing imbalances on 1990 commuting patterns at both place of residence and place of work are investigated. The research builds upon previous work I conducted on jobs-housing balance in the Bay Area (Cervero 1986a, 1989). Since the San Francisco region has not embarked on any significant regional programs to balance employment and residential development, it represents a context where market forces alone have largely shaped metropolitan growth. Thus, the analysis of trends in jobs-housing balance in the San Francisco region can provide insights into the degree to which the colocation hypothesis holds. The Bay Area is also a suitable case context because of the rapid rates of suburbanization there during the 1980s. The share of jobs outside of the central cities (San Francisco, Oakland, and San Jose) increased from 59.8 percent in 1980 to 64.7 percent in 1990. Suburban growth pressures during the eighties sparked interest in managing regional growth, partly in response to such parochial actions as the passage of growth moratoria and the practice of fiscal zoning by local jurisdictions (Fulton 1991). The Bay Vision 2020, a coalition of business and government interests, pushed in 1992 to form the nation's first regional government, in part to set targets for subregional jobs-housing balance; however, the California legislature blocked the initiative. Jobs-housing balance remains a passionately debated issue in the Bay Area and elsewhere in the state.

This macro-level study of jobs-housing balance in Bay Area cities is followed by a more micro-level analysis of the residential locations and commuting patterns of workers from Pleasanton, a fast-growing suburban community. Particular attention is given to changes in commuting distances and to the influences of housing prices on the residential locational choices of Pleasanton's work force. The paper concludes with a discussion of the policy implications of the research findings.

Jobs-Housing Balance Trends in the Bay Area

Using 1980 census data on place of residence and employment, in the earlier *JAPA* article I found considerable variation in the ratios of jobs to employed residents (J/ER) among the Bay Area's largest cities. Table 1 updates this index to 1990 for the 23 largest cities (in 1990), and shows percentage changes during the 1980s. (Cities have been ordered in table 1 from the highest to the lowest 1990 J/ER ratios.) Map 1 shows the locations of the 23 Bay Area case cities. Both years of data were obtained from the U.S. Census Population and Housing data files.

Before interpreting these data, several caveats are in order. One is that ratios of jobs to employed residents (J/ER) are presented in lieu of jobs-to-housing ratios, since the latter index must be adjusted for average number of workers per household, not easily obtainable; a jobs-to-employed-residents ratio requires no such adjustment. Second, the use of cities as geo-

TABLE 1. Jobs-housing balance statistics for large cities in the San Francisco Bay Area, 1980–1990

Cities	Employed Residents[a] 1980	Employed Residents[a] 1990	Employed Residents[a] % Change	Total Workers (Jobs)[b] 1980	Total Workers (Jobs)[b] 1990	Total Workers (Jobs)[b] % Change	Ratio of Jobs to Employed Residents[c] 1980	Ratio of Jobs to Employed Residents[c] 1990	Ratio of Jobs to Employed Residents[c] % Change
Palo Alto	30,550	31,720	3.8	61,912	79,232	28.0	2.03	2.50	23.3
Santa Clara	48,262	53,687	11.2	83,067	108,924	31.1	1.72	2.03	17.9
Sunnyvale	60,526	69,332	14.5	90,603	109,684	21.1	1.50	1.58	5.7
Walnut Creek	25,194	30,645	21.6	29,970	47,965	60.0	1.19	1.57	31.6
San Francisco	333,762	382,309	14.5	458,745	567,112	23.6	1.37	1.48	7.9
Berkeley	49,767	54,590	9.7	58,995	74,859	26.9	1.19	1.37	15.7
Santa Rosa	35,680	54,459	52.6	39,665	69,104	74.2	1.11	1.27	14.1
San Leandro	30,767	33,566	9.1	38,676	42,059	8.7	1.26	1.25	−0.3
Hayward	44,608	54,012	21.1	50,238	67,508	34.4	1.13	1.25	11.0
Pleasanton	17,024	29,570	73.7	7,161	33,325	365.4	0.42	1.13	167.9
Oakland	140,114	160,160	14.3	166,102	177,810	7.0	1.19	1.11	−6.3
Redwood City	29,267	35,807	22.3	24,568	37,569	52.9	0.84	1.05	25.0
Mountain View	35,732	42,132	17.9	47,160	43,490	−7.8	1.32	1.03	−21.8
Fairfield	25,558	37,015	44.8	23,024	36,903	60.3	0.90	1.00	10.7
Richmond	28,662	37,916	32.3	31,518	36,229	14.9	1.10	0.96	−13.1
San Mateo	41,383	47,192	14.0	33,484	45,069	34.6	0.81	0.96	18.0
Napa	23,559	29,013	23.2	17,405	27,649	58.9	0.74	0.95	29.0
Concord	51,260	59,658	16.4	35,071	56,449	61.0	0.68	0.95	38.3
Alameda	33,200	43,668	31.5	22,354	39,992	78.9	0.67	0.92	36.0
San Jose	301,769	400,932	32.9	200,791	334,630	66.7	0.67	0.83	25.4
Vallejo	34,683	49,906	43.9	29,859	39,509	32.3	0.86	0.79	−8.0
Fremont	63,879	94,769	48.4	33,982	71,771	111.2	0.53	0.76	42.4
Daly City	38,775	47,420	22.3	13,603	20,666	51.9	0.35	0.44	24.2
Unweighted Average	66,260	81,716	25.9	69,476	94,239	56.4	1.02	1.18	21.5
Standard Deviation	83,133	101,711	16.9	96,774	122,833	72.7	0.41	0.44	36.0

Notes:

a Number of residents in the city who are employed

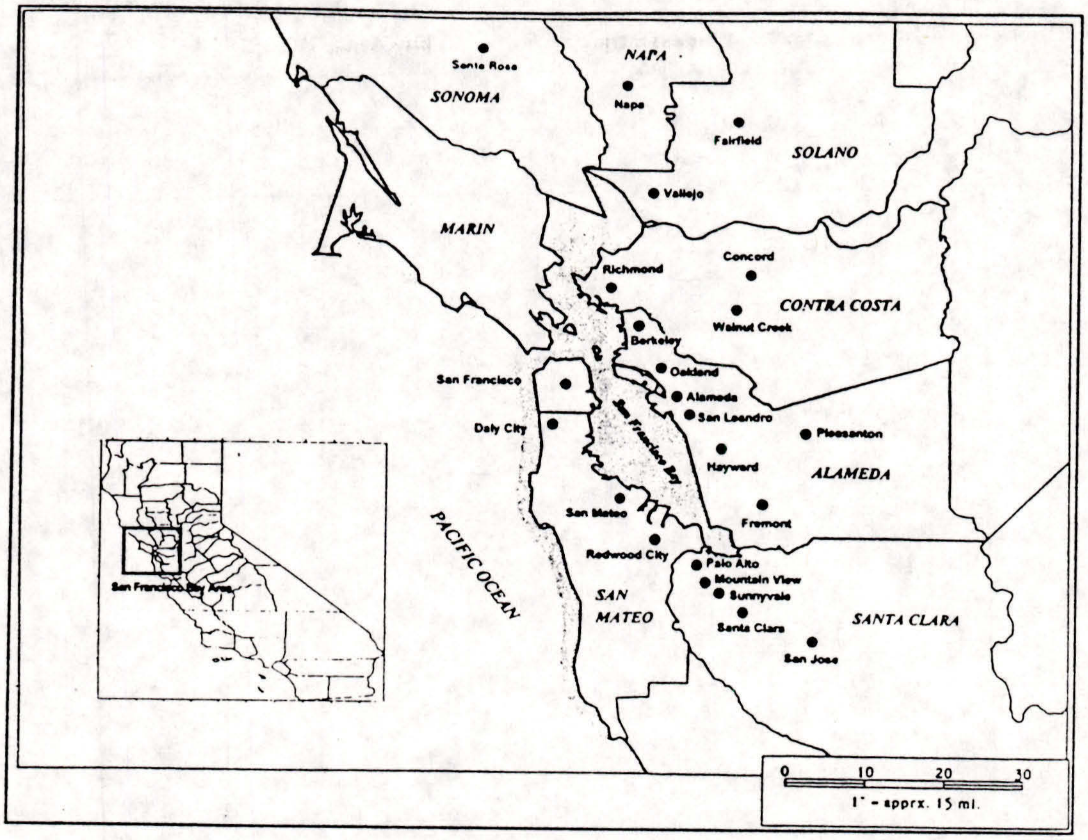
b Number of workers in the city

c Total workers divided by total employed residents (b/a)

Source: U.S. Bureau of the Census, 1980 and 1990

graphic units for measuring balance is admittedly suboptimal, since municipal boundaries are political artifacts that do not always capture the spatial dimensions of commute sheds (Cervero 1991; Downs 1992; Giuliano and Small 1993).[5] As Hamilton et al. (1991) note, however, there is merit in using cities to analyze jobs-housing balance, since they are the entities empowered to regulate land use (mainly through zoning) and are most directly responsible for how metropolitan areas grow. Battles over jobs and housing also are most often waged at the municipal level. The city of Oakland recently filed suit against the neighboring city of Emeryville on the very grounds that Emeryville's explosive employment growth in the absence of sufficient housing construction has burdened Oakland with more traffic and additional demands for affordable housing. Nonetheless, the geographic size of cases for studying jobs-housing balance does matter. The larger the size, the more likely the balance—at the extreme, planet earth has a perfect balance of jobs and employed residents. For the most part, this study's use of the region's most populous cities as cases produced relatively large geographic units (mean = 32.8 square miles; standard deviation = 34.5 square miles).[6]

Table 1 reveals a trend toward greater balance for most Bay Area cities during the 1980s. Using a ratio of 1 to signify balance, the table shows that 14 of the 23 cities (61 percent) were more balanced in 1990 than in 1980 (i.e., had J/ER ratios closer to 1 in 1990). Most large Bay Area cities had faster employment than housing growth during the 1980s, reflected in higher 1990 J/ER ratios. Ten of the eleven "bedroom" cities with more employed residents than jobs in 1980 saw jobs grow faster than housing [illegible] the



MAP 1. Twenty-three largest cities in the San Francisco Bay Area, 1990

only exception). That is, most suburban bedroom communities became more balanced. The most dramatic change was in Pleasanton, which changed from a dormitory community to a job-surplus city in the wake of massive office park development during the 1980s.

The pattern was quite different for cities that were already established in 1980 as major job centers. Of the ten with J/ER ratios over 1.10 in 1980, eight were even less balanced in 1990—that is, jobs grew faster than households did. The balance gap widened the most in three of the Bay Area's four cities that are most job-rich today—Palo Alto, Santa Clara, and Walnut Creek. These three cities recorded tremendous gains in predominantly white-collar and high-technology jobs during the eighties; for example, Walnut Creek's workforce size rose from 30,000 to 48,000 (60 percent) over this period. The Silicon Valley community of Mountain View stands out as the only job-rich city in 1980 that became balanced ten years later, a testament to the city's ambitious efforts to attract housing development, especially apartments and condominiums, in the face of rapidly deteriorating traffic conditions. For most other cities listed in table 1, market forces largely dictated the amount, pace, and type of growth that occurred.

In summary, there appears to have been a general trend toward balance in the Bay Area's largest cities during the 1980s, which supports the co-location hypothesis. The adjustment was mainly in the form of bedroom communities becoming more balanced. For the most part, the imbalances in job-rich cities widened in the eighties.

Trends toward Self-Containment in the Bay Area

Ratios of jobs to employed residents indicate only the potential for balance. The degree to which that potential is realized is reflected by the share of the jobs in a community that are actually filled by residents, and conversely by the share of workers finding a place to live in that community—or what has been called "self-containment" (Cervero 1989). Self-containment refers to achieving a built form that allows people to live, work, shop, and recreate within a community (Burby and Weiss 1976). In a study of British new towns, Thomas (1969) first devised a measure of self-

TABLE 2. Self-containment statistics for large cities in the San Francisco Bay Area, 1980–1990

Cities	Percent Locally Residing Workers[a] 1980	1990	% Pt. Change[d]	Percent Locally Working Residents[b] 1980	1990	% Pt. Change[d]	Independence Index[c] 1980	1990	% Change
Palo Alto	19.7	17.6	−2.1	39.9	43.9	4.0	0.28	0.32	11.7
Santa Clara	16.8	14.5	−2.3	28.9	29.3	0.4	0.19	0.19	0.3
Sunnyvale	22.6	20.0	−2.6	33.8	31.6	−2.2	0.24	0.21	−9.7
Walnut Creek	20.6	18.5	−2.1	24.5	28.9	4.4	0.16	0.19	19.7
San Francisco	55.0	54.2	−0.8	75.6	80.4	4.8	1.09	1.23	12.8
Berkeley	37.6	36.2	−1.4	44.6	49.7	5.1	0.38	0.44	15.0
Santa Rosa	53.5	50.3	−3.2	59.5	63.8	4.4	0.68	0.74	8.8
San Leandro	23.9	22.4	−1.4	30.0	28.1	−1.9	0.21	0.19	−8.3
Hayward	28.9	26.8	−2.1	32.5	33.5	1.0	0.23	0.24	2.1
Pleasanton	50.9	29.0	−21.8	21.4	32.7	11.3	0.17	0.24	41.2
Oakland	39.4	42.2	2.8	46.7	46.8	0.2	0.41	0.42	3.0
Redwood City	33.5	26.2	−7.3	28.1	27.4	−0.7	0.20	0.19	−7.7
Mountain View	20.4	20.1	−0.4	27.0	20.7	−6.3	0.18	0.13	−26.4
Fairfield	59.5	49.3	−10.2	53.6	49.2	−4.4	0.62	0.48	−21.5
Richmond	28.4	27.6	−0.8	31.2	26.3	−4.8	0.22	0.18	−18.8
San Mateo	33.4	30.4	−3.0	27.1	29.0	2.0	0.19	0.21	6.5
Napa	62.9	60.2	−2.7	46.5	57.4	10.9	0.51	0.70	35.6
Concord	42.0	33.8	−8.2	28.8	32.0	3.3	0.22	0.24	7.3
Alameda	40.3	45.8	5.5	27.1	41.9	14.8	0.20	0.37	82.5
San Jose	64.0	62.0	−2.0	42.6	51.8	9.1	0.46	0.60	31.5
Vallejo	57.5	53.3	−4.2	49.5	42.2	−7.3	0.53	0.40	−24.2
Fremont	57.7	43.3	−14.4	30.7	32.8	2.1	0.28	0.26	−3.9
Daly City	32.3	27.1	−5.2	11.3	11.8	0.5	0.07	0.07	1.2
Unweighted Average	39.2	35.2	−3.9	36.6	38.8	2.2	0.34	0.36	6.7
Standard Deviation	15.5	14.6	−1.0	14.2	15.3	1.1	0.23	0.26	13.1

Notes:

a Percent of workers who reside locally

b Percent of employed residents who work locally

c Percent of residents working locally divided by the sum of the percent of residents working outside a city plus the percent of employees living outside a city

d Percentage point change, representing absolute changes in percentage values

Source: U.S. Bureau of the Census, 1980 and 1990

containment. According to Thomas (1969, 338), all British new towns were designed to be "self-contained and balanced." For tracking changes in self-containment from 1951 to 1966, Thomas created an "Independence Index"—the number of internal (within community) work trips divided by the sum of in and out (external) work trips. The higher the value, the more "independent," or self-contained, the community. Thomas found that early (Mark I) British new towns became more self-contained over the course of the 1960s. More recently, Breheny (1990) has shown that self-containment within British new towns has declined, though the newest generation of British new towns have maintained high levels of self-containment (Cervero 1995).

Table 2 presents 1980–1990 changes in Independence Indexes computed for the 23 Bay Area cities, along with two other measures: the percentage of locally residing workers and the percentage of locally working residents. The percentage of locally residing workers refers to the share of workers who reside in the same city where they work. The percentage of locally working residents refers to the share of employed residents who work in their home city. High values for both percentages signify self-containment. (Cities are ordered in table 2 as in table 1—according to J/ER ratios.)

Trends in Independence Indexes

In all, 15 of the 23 Bay Area cities (65 percent) became more self-contained during the 1980s—that by 1990, they had higher Independence Indexes. The average increase in the Independence Index, however, ... fairly modest—around 7 percent. Job-rich cities t... .d to become relatively more self-contained during the 1980s; 7 of the 9 cities with J/ERs above 1.25 had higher Independence Indexes in 1990. The East Bay city of Alameda had the fastest growth in internal commutes (owing to the expansion of its military base in the 1980s), followed by two suburban/exurban communities, Pleasanton and Napa. External commuting grew the fastest in Mountain View (despite its housing expansion) and Vallejo (the only bedroom community that had faster job growth than housing growth in the 1980s).

Overall, despite this progress, most Bay Area cities were not very self-contained in 1980 or in 1990; on average, around twice as many people commuted in and out as commuted within cities. The only Bay Area city that can lay genuine claim to being self-contained is San Francisco itself: four out of five of its employed residents worked in the city in 1990. The least self-contained city is Daly City, the western terminus of the region's BART rail system in 1990. The absence of many self-contained cities and the extensive cross-haul commuting that occurs each workday between Bay Area cities underscores the high degree of economic interdependence within the region. In other words, ...y Area cities rely heavily on each other for importing ... :porting labor.

Trends in Residing and Working Locally

While Bay Area cities generally inched toward more self-containment, this trend appears to have been mainly due to businesses locating near labor pools, enabling residents to find jobs within their communities. Table 2 shows that the share of locally residing workers fell in 21 of the 23 cities, and the share of locally working residents rose in 16 cities. Pleasanton, the city that during the 1980s had the fastest employment growth (and also made the greatest relative progress toward balance), was where the share of the workforce residing locally dropped the fastest. A significant proportion of Pleasanton's new workers ended up living outside the city, either by choice or force (e.g., because of insufficient housing supply), an issue discussed later in the paper. Cities with the fastest growth in residents with local jobs were Alameda (54.6 percent) and Pleasanton (52.9 percent), both of which were fairly balanced in 1990.

Bay Area cities with the greatest job surpluses in ...90, namely the Silicon Valley cities of Santa Clara, ... Alto, and Sunnyvale, and Walnut Creek in the East Bay, also had the lowest shares of workers living locally. Cities where most employed adults left daily for jobs elsewhere were the predominantly bedroom communities, like Daly City, or balanced communities, like Mountain View. In Mountain View, just one of five employed residents worked locally and one of five workers lived locally in 1990. Thus, while Mountain View became fairly balanced during the 1980s by adding more housing, most of its new residents worked elsewhere.

Associations between Balance and Self-Containment

The association between balance and self-containment in the Bay Area is fairly weak. Table 3 shows that the correlation between the "Balance" and "Independence Indexes" is −.250 for 1980 and −.045 for 1990. (The "Balance Index" was constructed as the absolute difference between the jobs-to-employed-residents ratio and 1; the smaller the value, the greater the balance—for example, a zero value signifies that jobs equal employed residents.[7]) This suggests that balanced communities tend to have higher shares of internal (presumably shorter) commutes. The fact that the correlation fell close to zero in 1990 suggests that the link between balance and self-containment was far weaker at the end of the decade than at the beginning.

These weak correlations underscore the fact that cities have to do more than achieve comparable counts of jobs and housing units to be self-contained. Cities like Redwood City, San Mateo, and Mountain View were fairly balanced in 1990, with J/ER ratios between 0.96 and 1.05, yet in all three communities, fewer than

TABLE 3. Correlation of jobs-housing balance and self-containment indicators, 1980 and 1990

	Independence Index	Locally Residing Workers	Locally Working Residents
1980			
Balance Index[a]	−.250	−.299	−.136
Jobs/Employed Residents	.130	−.587**	.140
1990			
Balance Index[a]	−.045	−.448*	.006
Jobs/Employed Residents	.071	−.469*	.189

Notes

[a]Balance Index = | (Jobs/Employed Residents) − 1 |

**Significant at .01 level

*Significant at .05 level

30 percent of workers resided locally and fewer than 30 percent of employed residents worked locally. Thus these communities had plenty of live-work opportunities, yet most residents out-commuted and workers in-commuted. This highlights the flaw in using simple jobs-housing balance ratios as public policy targets. If reducing VMT and encouraging more walking, biking, and transit riding are explicit policy objectives, then building housing suited to the earnings and preferences of local workers and attracting industries suited to the skill levels of local residents could very well pay more dividends than ensuring parity in numbers of jobs and housing units would. Of course, some argue, other policies, like road pricing and parking restraints, may do more to reduce VMT than land-use initiatives like jobs-housing balance (Wachs et al. 1993; Giuliano 1995).

Balance was most strongly correlated with shares of workers residing locally. The region's two most exurban communities, Fairfield and Napa, for example, were nearly perfectly balanced and had over half of their work forces living in the community. As noted, the region's most job-rich and least balanced cities (e.g., Palo Alto, Santa Clara) imported the largest shares of workers. These cities had higher shares of residents who worked in the community (to be expected, given the relatively large number of job opportunities nearby); however, for most other cities, these two measures were weakly associated.

The relatively strong negative correlation between balance and locally residing workers is illustrated in figure 1 for 1980 and in figure 2 for 1990. In general, housing-rich cities had large shares of workers living locally, whereas job-rich cities had low shares. Figures 1 and 2 also organize the cities into three groups: (1) housing-rich, or dormitory, communities with J/ER ratios below 0.80; (2) balanced communities, with J/ER ratios between 0.80 and 1.25; and (3) job-rich, or corporate, communities, with J/ER ratios above 1.25. The boundaries, 0.80 and 1.25, are the values 0.5 standard deviations below and above the mean 1980 J/ER value of 1.02.

Figure 1 shows that in 1980, 6 of the 7 dormitory communities had above-average shares of locally residing workers. And 5 of the 6 job-rich cities had below-average shares of locally residing workers. San Francisco was the outlier among job-rich cities, having over half of its workforce living in the city.

If the 1980 and 1990 graphs were overlaid, one would see that most data points shifted to the right in 1990. More specifically, during the 1980s most bedroom communities became balanced, as new businesses moved in, and most corporate communities became more imbalanced, as job growth continued to outpace housing construction. Overall, more communities fell in the balance range in 1990: 13 of the [illegible] had J/ER ratios between 0.80 and 1.25, versus 10 in 1980. Again, this generally supports the co-location hypothesis, however with qualifications, the main one being that market adjustments to jobs-housing imbalances hold true mainly for historically housing-rich cities. Specifically, during the 1980s, jobs followed labor markets, going to suburban cities with large population bases and making them more balanced. However, in the other suburban cities, housing development did not adjust to job surpluses. Whether as a result of fiscal zoning, anti-growth movements, or NIMBY resistance, the lag in housing production has unavoidably meant that a vast majority of Bay Area workers live outside their community of employment.

Balance, Containment, and Housing Prices

In the previous section, I noted that job-surplus cities tended to have few workers living locally. By definition, part of the reason is a deficit of housing available to workers. Dowall (1984) and Landis (1986) have shown that lags in housing production in the Bay Area caused by growth restrictions have markedly increased average housing prices. Research shows, moreover, that many moderate-income and nonprofessional workers are priced out of the local housing market in well-to-do corporate communities (Cervero 1989; Deka 1990; Humphrey 1990). The 1990 correlation between the J/ER ratio and "relative" housing price (median single-family home value/median household income) was .321. Thus, job-rich cities like Palo Alto and Sunnyvale tended to have relatively high housing prices.[8] And the correlation between locally residing workers and relative housing price was −.425, significant at the .05 probability level. This suggests that the more expensive housing is in a community, the less likely workers are to reside locally.

A regression of the Independence Index on relative housing price and two other significant explanatory variables is presented in table 4. The model further suggests that high housing prices have a displacing effect on workers, though this variable is significant only at the 0.12 probability level. Cities with relatively high housing prices tended to have low rates of internal (within community) commuting and high shares of workers commuting in. This calculation controls for size of the community, which generally increases the share of internal commutes, and vehicle ownership levels (a proxy for income as well as automobility

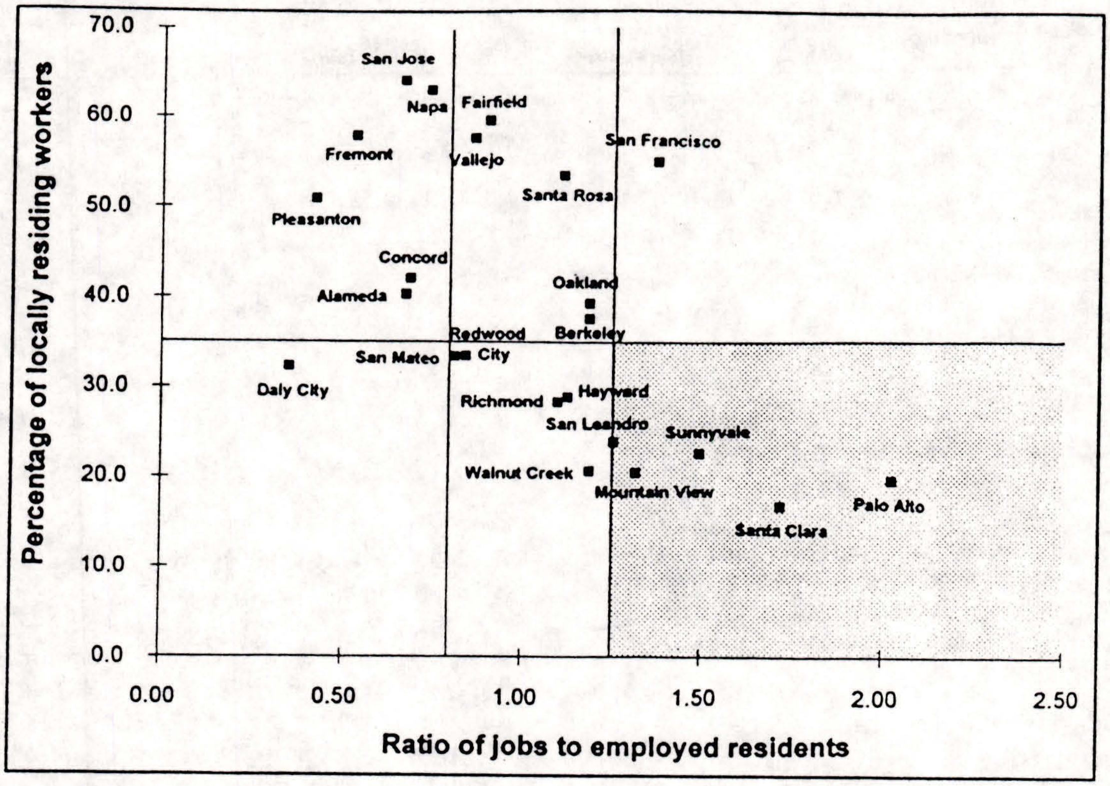


FIGURE 1. Ratio of jobs to employed residents versus percentage of locally residing workers, large Bay Area cities, 1980

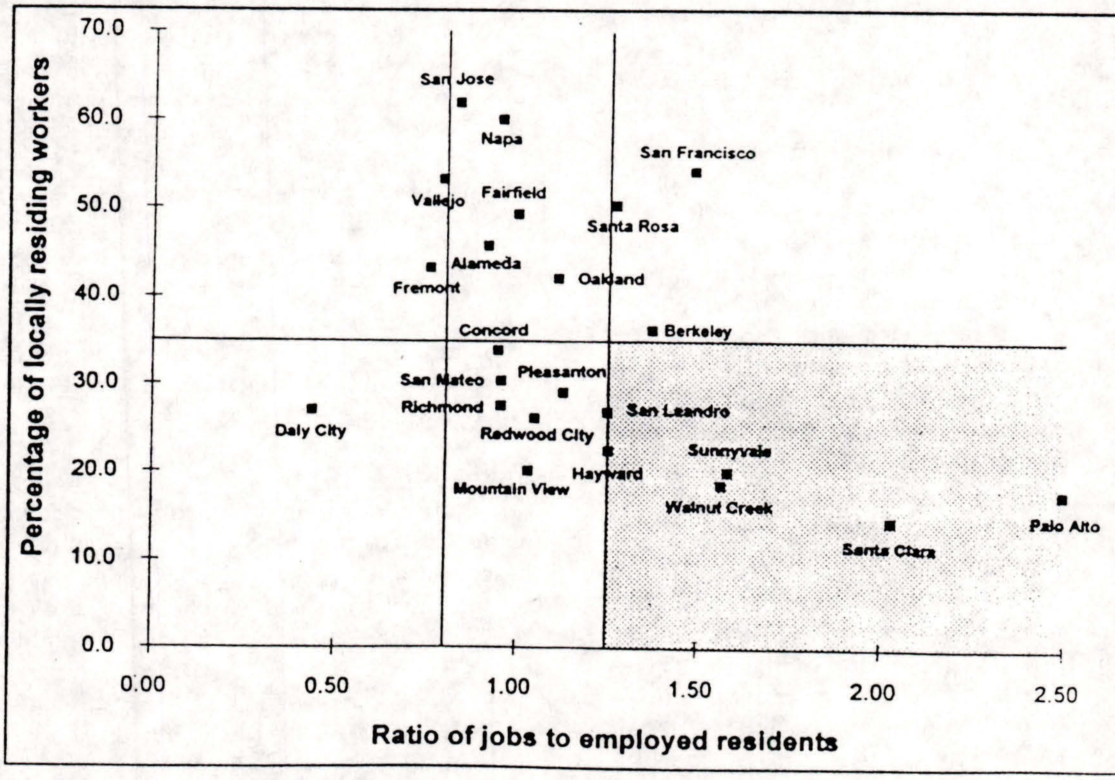


FIGURE 2. Ratio of jobs to employed residents versus percentage of locally residing workers, large Bay Area cities, 1990

TABLE 4. Model for predicting Independence Index for large Bay Area cities, 1990

Dependent Variable: Independence Index (internal commutes/external commutes)

	Coefficient	Standard Error	Significance
Housing price index (median single-family home value/ median household income)	−0.0573	0.0403	0.119
No. of employed residents in city	0.0015	0.0004	0.002
No. of vehicles per household	−0.3681	0.1853	0.062
Constant	1.1633	0.4291	0.014

No. of cases = 23. R^2 = .549. F = 7.305; prob. = 0.002.
Source: U.S. Census, Summary Tape File 3A

which generally increases the share of external commutes. Overall, this analysis suggests that high housing prices induce external commuting by compelling some workers to live in another city.

Balance, Containment, and Commuting

This section examines the statistical relationships between jobs-housing balance, self-containment, and characteristics of commute trips in 1990. Analyses are presented for: (1) place of residence—that is, the commute characteristics of the employed residents in the 23 cities; and (2) place of employment—that is, the commute characteristics of workers in the 23 cities. Commute data include journey-to-work times, distances, and modal splits. These data were compiled from the 1990 Census Transportation Planning Package (CTPP) for the San Francisco-Oakland-San Jose CMSA, Part 1 (place of residence) and Part 2 (place of work). Average straightline commute distances were estimated for each of the 23 cities, for work trips both by employed residents and by workers.[9] The average commute VMT per employed resident and per worker of each city also were estimated, by merging commute distance and modal occupancy data.[10]

Commuting by Employed Residents

Little relationship was found between measures of jobs-housing balance or self-containment and such journey-to-work characteristics of employed residents as commuting times, distances, and modal splits. This finding was expected, since problems of jobs-housing imbalance in the Bay Area are mainly those of not enough nearby housing for the workers of job-surplus cities; thus it is the commute trips of workers, not residents, that are most likely to be affected by imbalance. In fact, employed residents of job-surplus cities tended to average the shortest commutes. For the 23 cities studied, the correlation between J/ER and employed-resident commute times was −0.51. The average commute time for employed residents for the 9 Bay Area cities with J/ER ratios over 1.20 was 22.9 minutes. For the remaining 14 cities with lower ratios, the average commute was two minutes longer—24.9 minutes. In each of the region's three most job-rich cities, Palo Alto, Santa Clara, and Sunnyvalle, employed residents averaged commutes of just 19 minutes.

The only other reasonably significant association found were that high rates of internal commuting resulted in higher shares of walk trips and lower shares of drive-alone trips. The associations between the percentage of locally working residents and modal splits were r = .443 for walking and r = −.386 for driving.[11] Thus, cities with large shares of residents working in the community can be expected to average more work trips by foot and fewer by automobile, all else being equal. This suggests there are likely to be some environmental benefits from self-containment, however marginal, mainly in the form of less VMT and tailpipe emissions.

Commuting by Workers

Because jobs-housing mismatches are most acute in job-rich cities, it was expected that any negative transportation consequences would show up in the commuting statistics of workers in these cities. Table 5 largely confirms these expectations. The table presents three types of comparisons, using Analysis of Variance (ANOVA). The first is between commuting statistics for high job-surplus cities (where J/ER > 1.55) and those for all remaining Bay Area cities.[12] The second comparison is trinary: job-surplus (J/ER > 1.25) versus balanced (0.8 < J/ER < 1.25) versus housing-surplus (J/ER < 0.80).[13] The final comparison is a

TABLE 5. Comparison of commuting characteristics among classes of Bay Area cities, 1990

	Number	Mean Worker Commute Times (Minutes)	Mean Ratio of Commute Times[a]	Mean Drive-Alone Commutes (%)	Mean Commute VMT Per Employee
Comparison 1:					
High-Job-Surplus Cities[b]	4	26.5	1.28	78.3	8.41
Other Cities	18	23.8	0.97	74.3	7.90
		(F = 3.04)*	(F = 10.44)**	(F = 1.11)	(F = 1.02)
Comparison 2:					
Job-Surplus Cities[c]	7	26.1	1.17	77.1	8.32
Balanced Cities[c]	11	24.1	1.00	75.0	7.94
Housing Surplus Cities[c]	3	23.1	0.81	72.7	7.87
		(F = 1.92)	(F = 4.29)**	(F = 0.93)	(F = 0.98)
Comparison 3:					
Low Internal Commutes[d]	12	25.4	1.07	77.9	8.43
Moderate Internal Commutes[d]	7	24.0	1.00	69.1	7.61
High Internal Commutes[d]	4	23.8	0.98	68.5	6.55
		(F = 0.79)	(F = 0.83)	(F = 2.43)*	(F = 6.17)**

a Mean commute time of workers divided by mean commute time of employed residents
b Job-to-Employed Resident ratio exceeds 1.55: Palo Alto, Santa Clara, Sunnyvale, and Walnut Creek.
c Job-Surplus: J/ER > 1.25; Balanced: 0.8 ≤ J/ER ≤ 1.25; Housing-Surplus: J/ER < 0.80.
d Low Internal Commutes: Independence Index < 0.25; Moderate Internal Commutes: 0.25 ≤ Independence Index ≤ 0.50; High Internal Commute: Independence Index > 0.50.

Significant at 0.05 probability level
Significant at 0.10 probability level

cording to levels of internal commuting—low, medium, or high. (See tables 1 and 2 for the cities in each class.)

Workers in high job-surplus cities averaged one-way commutes that were 2 minutes and 40 seconds longer than those for their counterparts from other Bay Area cities.[14] The biggest difference was in the average one-way commute times of those working in job-surplus cities versus times for those in housing-surplus cities—a 3-minute differential. Cities with high rates of external commuting also averaged relatively high worker travel times, though this relationship was not statistically significant.

A useful way to gain insight into the *relative* commute times of workers in a city is to compare them to the commute times of employed residents from the same city. Table 5 reveals appreciable differences according to the levels of jobs-housing balance. In the high job-surplus cities, workers averaged commutes that were 28 percent longer than those of employed residents. For the remaining Bay Area cities, commute durations were, on average, fairly similar for workers and for employed residents. The table also shows that in bedroom communities, residents commuted nearly 20 percent longer than did workers.[15]

While workers in job-surplus cities relied more on drive-alone commuting, differences were not large or statistically significant.[16] The greatest differences were according to levels of self-containment. Cities with high rates of external commuting (independence index < 0.25) averaged well over three-quarters of workers who solo-commuted. In more self-contained cities, workers were less inclined to drive alone. Public transit commuting made up much of the difference. The correlation between the Independence Index and workers' transit modal splits was .65.

Combining statistics on commuting distances and occupancy levels (according to mode) produced estimates of commute VMT per employee, the last column in table 5. If there is any single indicator that reflects the regional mobility and environmental implications of jobs-housing mismatches, it is this statistic. In general, job-surplus cities averaged more commute vehicle miles per worker; differences, however, were not statistically significant. The slightly higher VMT per worker was a product of slightly longer distance commutes and slightly higher shares of low-occupancy vehicular travel (e.g., drive-alone commuting); however, there was a fair amount of variation within classes of cities.

The largest differences in VMT per worker were according to levels of self-containment. On any given workday, cities with Independence Indexes under 0.25 (low internal commuting) averaged nearly two more vehicle miles per worker (in one direction) than did cities with Indexes above 0.50 (high internal commuting). Summed over all workers for some 300 work days per year, this difference amounts to over 800 million more vehicle miles of commuting annually in these noncontained cities as compared to self-contained cities.[17]

In sum, imbalances and noncontainment did significantly affect commuting in the Bay Area in 1990. It was the workers of these imbalanced and noncontained cities that were most affected; employed residents of these places, in contrast, were largely unaffected. Longer durations, higher automobile dependency, and more VMT per employee characterized the commutes of workers in either job-surplus cities or cities with high external commuting. In most cases, these cities were one and the same, since the most job-rich cities were also the least self-contained. The implication of these findings is that important transportation and environmental benefits could accrue from adding more housing in or near job-rich cities that matches the preferences of workers; achieving a numerical balance of jobs and housing, in and of itself, is unlikely to yield many dividends.

The Case of Pleasanton

The relationships among employment growth, jobs-housing balance, housing prices, and commuting were examined further for one of the 23 large Bay Area cities, Pleasanton. As noted, Pleasanton stands out among all of the cities studied for its rapid employment growth during the 1980s—365 percent, over three times as fast as the growth in any other Bay Area city. Pleasanton has been a major recipient of offices relocated out of downtown San Francisco and Oakland, as well as new start-up companies. A significant share of Pleasanton's growth has taken place in the Hacienda Business Park, a 860-acre, master-planned complex with over 4 million square feet of mixed use (though predominantly office) development and over 12,000 workers. Among all of the Bay Area cities studied, moreover, Pleasanton has made the greatest strides toward balance, having changed from a predominantly bedroom community in 1980 (J/ER ratio of .42) to a fairly balanced community in 1990 (J/ER ratio of 1.13). As noted, however, most new workers have taken up residence outside the city, which has resulted in fairly low levels of self-containment; four times as many people commute in and out of the city each day as within.

Pleasanton was one of the nation's first cities to enact a trip reduction ordinance in response to worsening traffic congestion (Cervero 1986b; Cervero and Griesenbeck 1988). Pleasanton is also unique for having some of the richest times series data on commuting patterns of the workforce found anywhere, having conducted annual surveys since 1984 as part of the city's traffic management program. The 1993 survey used in this analysis, for instance, provided detailed data on travel and place of residence for 14,804 workers, in companies with 10 or more employees, representing 71 percent of the city's workforce.

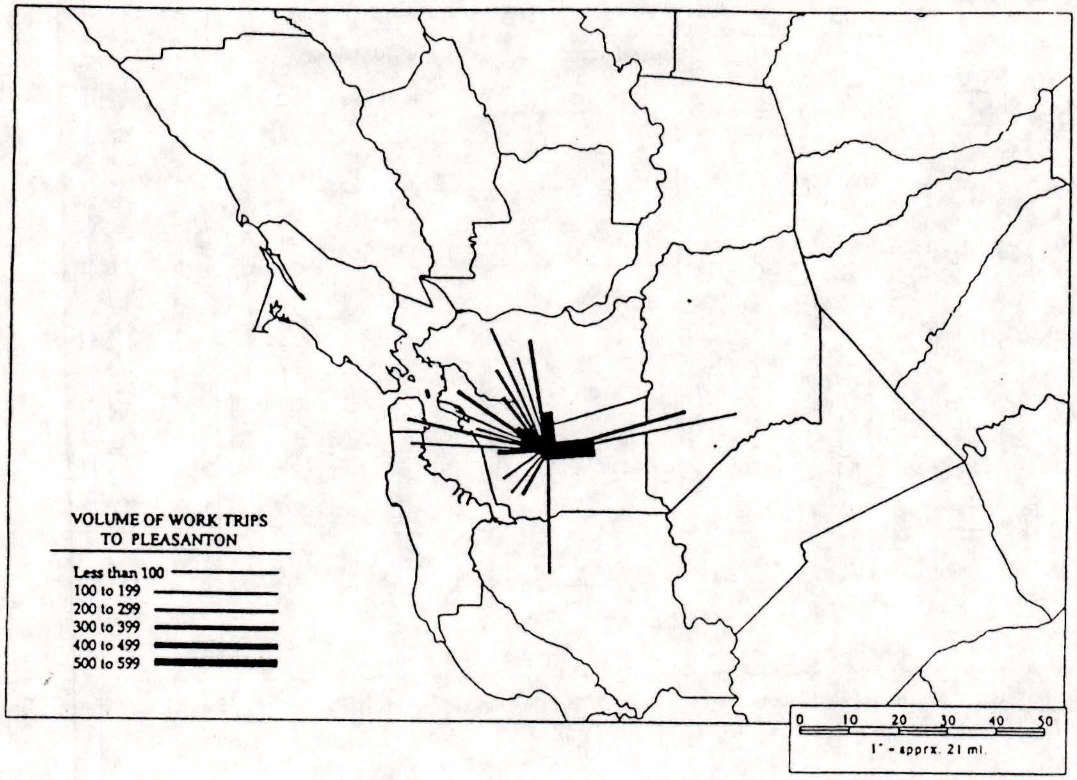
Trends in Residential Location and Journey-to-Work

The trend toward external commuting among Pleasanton's workforce is illustrated by the desire line maps shown in Maps 2 and 3. Changes in patterns and volumes of work trips to Pleasanton reveal a greatly expanded commute shed from 1985 to 1993. Most notable was the growth in reverse commutes from the West Bay (San Francisco and northern San Mateo County) to Pleasanton, as well as a tripling of commutes to and from California's central valley (the farthest east origins).

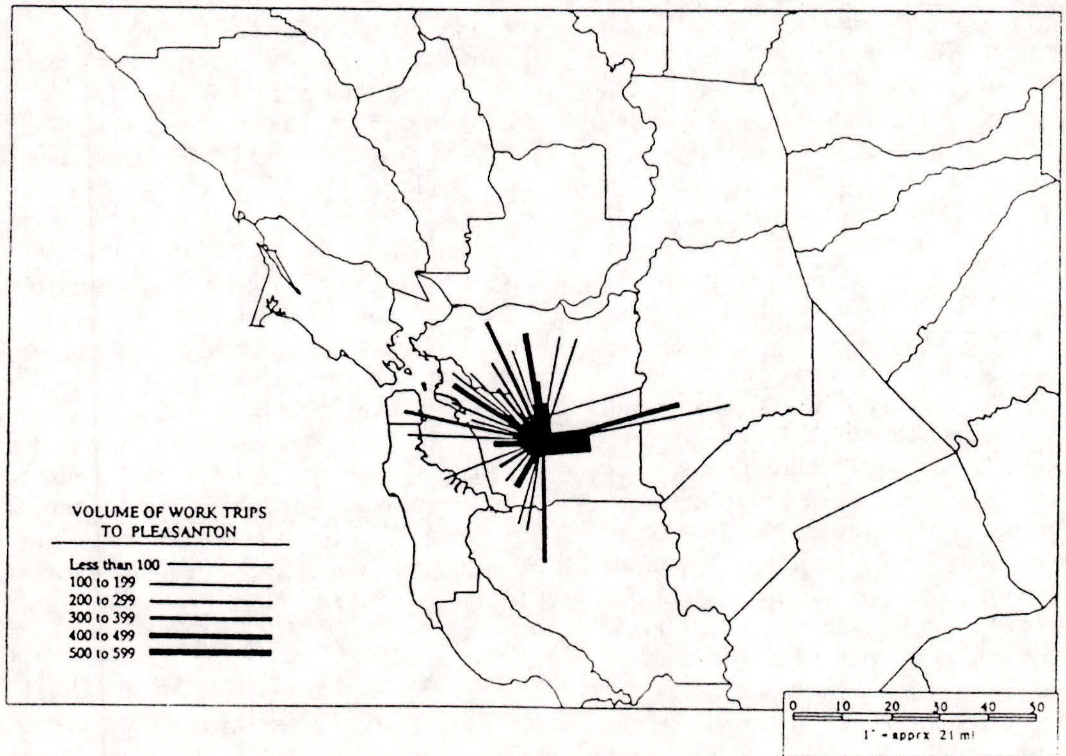
The expansion of Pleasanton's commute shed increased the average worker commute distance, as shown in figure 3 for the 1987–1993 period.[18] The share of workers commuting under 5 miles fell by 9 percentage points over this six-year period, matched by a 7 percentage points increase in the share commuting over 16 miles. The average commute distance for Pleasanton's workforce was 18.8 miles in 1993, considerably above the Bay Area's average of 14.4 miles (RIDES, Inc. 1994).

Pleasanton's Jobs-Housing Balance Dilemma

In many ways, Pleasanton is a classic case of the dilemma posed by using ratios of jobs to housing units to evaluate balance. Although it evolved into one of the Bay Area's most balanced communities during the 1980s, most workers live elsewhere and most residents work elsewhere. Thus, while jobs grew more than enough to match the number of employed residents, most of the new workers did not take up residence in Pleasanton, at least in part because long-



MAP 2. Desire line map of external work trip origins and destinations for Pleasanton workers, 1985



MAP 3. Desire line map of external work trip origins and destinations for Pleasanton workers, 1993

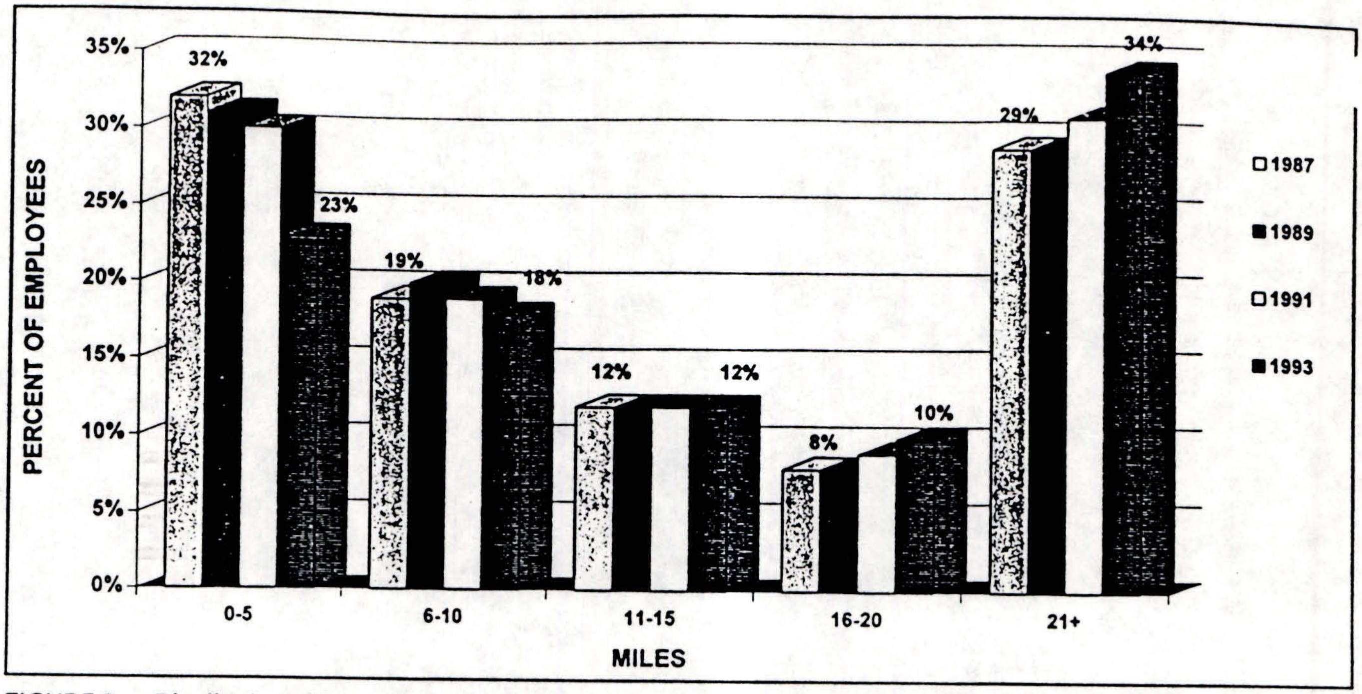


FIGURE 3. Distribution of journey-to-work distances for Pleasanton workers, 1987–1993. Each class interval (in miles) is grouped sequentially for the years 1987, 1989, 1991, and 1993.

time residents already occupied the existing housing stock. According to 1990 journey-to-work statistics, 35 percent of Pleasanton's employed residents worked in San Francisco, the Silicon Valley, or the dense Oakland-Fremont corridor paralleling Interstate 880.[19] Thus, as new jobs were created, most new workers found that Pleasanton's housing was already occupied by traditional suburban households whose workers commuted to downtown jobs. The housing units added were too few to accommodate many new workers. While Pleasanton's workforce grew from 7,161 in 1980 to 33,325 in 1990, or 365 percent, housing increased from 11,665 to 19,356 units, or only 66 percent, over that decade.

Most of the blame for the lag in housing production can be placed on growth moratoria rather than market inertia. Since the mid-1970s, Pleasanton has limited the number of residential building permits issued and new sewer hook-ups allowed each year, because of limited infrastructure capacity and a citizen backlash against growth. Such protectionist actions have become common in many fast-growing California cities in the wake of Proposition 13, California's landmark 1978 law that restricted the ability of local governments to raise property tax rates (Fulton 1991). In the late 1980s, the developers of Hacienda Business Park were actually prohibited from building over 2,000 housing units, including moderately dense apartments, that had been planned for their 860-acre property, because of a NIMBY-style revolt

There is some anecdotal evidence that the new housing that was built was not within reach of the earnings of many Pleasanton workers. In 1990, 69 percent of Pleasanton's work force had jobs in clerical, data processing, sales, services, labor, and other non-professional/nonmanagerial fields. Many were back-office workers relocated to branch offices during the 1980s. According to the 1990 census, the median annual earnings for Pleasanton workers was $33,033, with a fair amount of variation around this average (standard deviation = $29,515).[20] Pleasanton's housing stock, however, is among the most expensive in the Bay Area suburbs. The average single-family home in Pleasanton was worth $296,100 in 1990, compared to a median value of $225,300 for Alameda County and $250,100 for the nine-county Bay Area.[21] Assuming a 10 percent down payment and a fixed 30-year loan at 9 percent, to purchase the typical Pleasanton home would require an annual household income of $73,550 (assuming 35 percent of gross income goes towards mortgage payments), more than twice the earnings of the average worker.[22]

Influences of Housing Supply and Price on Residential Location

To further explore the sensitivity of the Pleasanton workforce to housing prices and supply, a gravity model was estimated using journey-to-work data from Pleasanton's 1993 employee transportation survey

The model predicted interzonal commute flows from other Bay Area cities (origin i) to Pleasanton (destination j) as a function of three variables: number of housing units in city i; median single-family home price in city i; and straightline distance from city i to Pleasanton. The model was of the form:

$$T_{ij} = k * [HU_i^{\beta_1} * HP_i^{\beta_2}]*\exp(-\theta D_{ij})*u_{ij} \quad (1)$$

where:

T_{ij} = Daily one-way commute trips from city i to j (Pleasanton)
HU_i = Housing units in city i
HP_i = Median single-family home price in city i
D_{ij} = Straightline distance from city i to j (Pleasanton)
u_{ij} = Random disturbance term for the i-j interchange
k = Constant
β_1, β_2, θ = Parameters, empirically estimated.

Thus a single-destination gravity model was estimated, with the impedance effects of distance expressed in a negative exponential, or entropy-maximizing (Wilson 1967), form.[23] In all, 63 city-i-to-Pleasanton commute interchanges were available for the analysis.[24] All housing data were obtained from the 1990 U.S. census, Summary Tape File 3A. The model was estimated using log-linear transformations and ordinary least squares.

Table 6 shows that Pleasanton's workforce was highly sensitive to both housing prices and supplies in choosing residential locations. The model shows that, controlling for housing supply and distance from Pleasanton, workers generally avoided living in cities with high housing prices. In that the estimated coefficients represent elasticities, we see that Pleasanton workers were more sensitive to housing prices than to housing supply when choosing residential locations. This is consistent with the finding of Levernier and Cushing (1994), who found that housing prices and quality are the most important determinants of residential distribution in urbanized parts of the U.S. Although table 5 is an incomplete model in that other factors, like quality of schools and neighborhoods, contribute to residential location choices (Quigley and Weinberg 1977; Clark and Burt 1980; Giuliano and Small 1993), the relative goodness-of-fit of the model (R^2 = .836) suggests that single-family home prices and housing availability were strong determinants of where Pleasanton's workers took up residence over the past decade. Moreover, the model explained 7 percent more of the variation in commute trip interchanges than did a basic single-destination gravity model using only population size of city i and straightline travel distance to Pleasanton as predictors.[25]

Conclusion

Changes in ratios of jobs to employed residents in the Bay Area during the 1980s suggest a general trend toward balance, lending some credibility to the colocation hypothesis. However, this was primarily attributable to jobs moving to labor markets—that is, dormitory suburban communities attracting more businesses and industries as they matured. In contrast, imbalances generally worsened in job-surplus cities. This was especially so in the Silicon Valley. While jobs followed labor markets, housing capital generally did not follow jobs. A consequence is that workers in job-surplus cities average longer duration commutes, more VMT per person, and higher rates of solo commuting. These outcomes, I conclude, are

TABLE 6. Gravity model for predicting residential locations of Pleasanton workers, 1993

Dependent Variable: Tij = Daily one-way commute trips from city i to j (Pleasanton)

	Coefficient	Standard Error	Significance
$\ln(HP_i)$	−0.775	0.243	.002
$\ln(HU_i)$	0.721	0.092	.000
D_{ij}	−0.123	0.011	.000
Constant	9.611	3.272	.005

Where:
HP_i = median single-family home price in city i
HU_i = number of housing units in city i
D_{ij} = straightline distance from city i to j (Pleasanton)
ln = natural logarithm
of cases = 63 R^2 = .756 F = 60.03, prob. = .000
City of Pleasanton, 1993 Pleasanton Transportation Survey

more of a planning failure than a market failure. Notably, many well-to-do, job-surplus communities have restricted housing growth for either fiscal or exclusionary reasons. In the absence of regional or state pressures or incentives, many communities have been unwilling to plan for and accommodate new housing, especially affordable units, where they are most needed. Efforts at the state level to legislate housing production, such as New Jersey's affordable housing mandates, have to date been mostly unsuccessful in bringing affordable housing to areas with large employment concentrations (Olenik and Cheng 1994).

Even if jobs-housing balance is attained, whether through government fiat or market forces, this research shows that it does not guarantee self-containment or reduced external commuting. While most Bay Area cities saw internal commutes increase, proportionally, during the 1980s, there was little correlation between balance and self-containment. Several communities were nearly perfectly balanced, yet fewer than a third of their workers resided locally, and even smaller shares of their residents worked locally. As a strict public policy target, jobs-housing balance is problematic, in that balance itself often has little bearing on commuting or, by extension, on air quality. More relevant to the reduction of commuting durations and VMT are adding more housing in or near job-surplus cities and reducing rates of external commuting, in part through the production of housing appropriate to the earnings and taste preferences of workers.

This research suggests that qualitative mismatches, such as between worker earnings and housing prices, are more of a barrier to balanced growth than are quantitative mismatches. Restricted housing production, especially in fast-growing cities, invariably drives up housing prices, displacing workers (Pollakowski and Wachter 1990). That seems to be what happened in Pleasanton, the Bay Area city with the fastest-growing employment, where lags in housing production have been matched by steadily increasing average commute distances. The blame for Pleasanton's housing deficit cannot be placed on the private sector. As noted, in the late 1980s the developers of Hacienda Business Park, Pleasanton's largest employment center, sought to build some two thousand condominium and apartment units on site, with the aim of marketing them to Hacienda's employees. Surrounding Hacienda Business Park are a number of established, single-family neighborhoods, whose residents vehemently opposed having moderate-density housing nearby. Because of NIMBY opposition, Pleasanton's city council denied the request to convert Hacienda from a massive office park to a mixed-use suburban complex with plentiful live-work oppc nities.

If the consequences of communities zoning out affordable housing are treated as a negative externality—namely, the displacement of local workers, who end up commuting more than they would have preferred, then a limited set of policy remedies might be considered. One is tax-base sharing, in which job-surplus cities share their local tax receipts with the bedroom communities that end up housing their workers (Cervero 1989; Downs 1994). In theory, this would remove the incentive to zone out apartments and other low-tax-yielding/high-service-demanding activities. Oregon recently signed into law a bill for local property tax abatement that seeks to "stimulate the construction of multiple-unit housing in the core areas of Oregon's urban centers to improve the balance between the residential and commercial nature of those areas, and to ensure full-time use of the areas as places where citizens of the community have an opportunity to live as well as work."[26] Initiatives like extraterritorial tax sharing and tax abatements generally require the passage of state enabling legislation, something of which few states other than Minnesota and Oregon seem capable. Two other options, fair share housing programs and regional control of land uses, are apt to receiv even less political support. Getting municipalities "think regionally and act locally" remains a huge obstacle. Downs (1992, 106) is skeptical: "Experience proves that 'natural' forces will not appropriately match local housing prices to the wage levels of locally employed workers within each subregion, because local government policies raise housing prices in many communities. The policies necessary to overcome such local regulatory barriers to affordable housing are complex and difficult to get adopted and to implement."

Economists argue that the preferred way to correct the negative consequences of imbalances or non-containment is to price transportation closer to true marginal social costs. Congestion tolls and mandatory parking fees, they argue, would probably eliminate the need for public policies like tax abatements and tax-sharing; faced with much higher travel costs, Americans would move closer to their jobs to economize on commuting. However, in a pluralistic, democratic society like ours, true market pricing may be even more unattainable than are public interventions that target housing production. So far, the only places in the world with even a cursory form of road pricing are either city-states ruled by heavy-handed centralized planning (Singapore) or sparsely populated, homogeneous countries (Norway). Martin Wachs (1995, 16 as chairman of a Transportation Research Board Committee on Congestion Pricing, concluded that except for "professors of transportation economics and planning—who hardly constitute a potent political force—I can think of few interest groups that would willingly and vigorously fight for the concept. . . ." In the absence of true market-rate pricing of transportation, I would contend that public interventions to promote and target housing production at least deserve consideration as second-best alternatives.

In earlier analyses of jobs-housing imbalances and mobility, I concluded by calling for various planning initiatives that in many instances are perhaps more far-reaching than is necessary. For a majority of cities in the San Francisco Bay Area, market forces worked toward greater balance in the 1980s; only in the case of job-surplus, typically well-to-do communities did the gap between employment and housing production significantly widen. And only in these cities did workers average longer duration commutes and more VMT per person. These findings argue against any universal standard for jobs-housing balance. Rather, policies for regional growth management that are deemed appropriate should be applied selectively and judiciously.

Critics have generally mischaracterized the debate over jobs-housing balance. Jobs-housing balance is about breaking down the barriers to residential mobility, not mandating where people live and work. Perhaps "jobs-housing imbalance," itself, is a misnomer. The problem lies with job-rich communities excluding categories of housing for fiscal and parochial reasons, to the detriment of their region at large. When developers are prevented from building housing near employment centers that is targeted at the local workforce, as recently happened in Pleasanton, California and Hunt Valley, Maryland, there are, I believe, grounds for some degree of policy intervention—to correct planning, not market, failure.

Many job-rich communities that had courted office and industrial development, but in recent times have shunned housing, are beginning to feel the economic repercussions. Suburban areas with the strongest real estate markets today are those that have shed their character as exclusively corporate centers or bedroom communities, and instead have become more balanced and diverse. Urban centers with vibrant mixed-use cores, like Reston and Ballston, Virginia, for instance, have weathered the economic downturn of the 1990s better than have major commercial and office centers, like nearby Tysons Corner, that require workers and shoppers to drive their cars on congested roads to reach them. In many parts of the country, companies are bypassing the "hot" real estate markets and "edge cities" of the 1980s in favor of outlying districts where housing is more plentiful and suited to the lifestyle preferences of their workforces (Leinberger 1993, 1995; Lockwood 1995). In greater Chicago, new employment growth has generally leapfrogged over the suburban employment hubs of the 1980s, like Schaumburg and Oak Brook, in favor of outlying districts, like Hoffman Estates (home to Sears' new merchandising headquarters), where housing is plentiful and affordable. A similar story can be told about greater Dallas, where most recent job growth has occurred on the rural fringes near Planto, well beyond the 1980 edge city boom areas of the Stemmens Freeway area and Las Colinas. In general, businesses will go where the labor force goes. Sooner or later, a lack of housing for local workers will translate into higher office and commercial vacancy rates, and economic decline.

To the degree that it exists, any problem of jobs-housing imbalance is fundamentally one of barriers to the production of suitable housing in job-rich cities and subregions. Over time, inadequate housing can lead to economic decline and exacerbate regional transportation and environmental problems. Thus, one of the many policy challenges to planners in coming years will be to break down down barriers to residential mobility, such as NIMBY resistance, large-lot zoning, and other exclusionary policies. Eliminating frictions to residential mobility and the flow of housing capital is likely to produce a well-functioning marketplace that provides sufficient housing and corporate locational choices, obviating any need for regional initiatives to balance jobs and housing.

AUTHOR'S NOTE

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NOTES

1. This theory holds that transportation technologies and locational decisions adjust to maintain a fairly constant amount of time devoted to travel, which according to Grubler (1990) is in the range of 1 to 1.5 hours per day. He notes that this time budget has remained "close to an anthropological constant" since ancient Rome. Hupkes (1982) calls this the "Law of Constant Travel Time."
2. One factor behind lengthening journeys-to-work could be the accelerated entry of women into the work force during the 1980s. The average daily travel distances of women increased sharply from 1983 to 1990 (Pisarski

1992a), which suggests that their vast influx into the labor force has probably had a strong influence on mean commuting times. However, because women average shorter commutes, work trips appear to have lengthened relatively more for men between 1983 and 1990 than did the national average.

3. External commuting also rose sharply during the 1980s. Americans' commutes to workplaces outside their metropolitan areas of residence rose by 3.5 million trips during the 1980s, from 5.4 percent to 7.6 percent of all commute trips (Pisarski 1992b).
4. Mean commuting times fell only in metropolitan New York, New Orleans, Salt Lake City, and Pittsburgh. In New York, average commute times fell from 33.7 minutes in 1980 to 31.1 minutes in 1990, a drop of nearly 8 percent, by far the biggest decline nationally.
5. The typical one-way commute distance, around 11 miles nationwide in 1990 (Hu and Young 1992) and 14.4 miles in 1993 for the San Francisco Bay Area (RIDES, Inc. 1994), could be viewed as the appropriate radius of a commute shed for studying jobs-housing balance. This, after all, is a radius whose area should, in theory, have equal counts of jobs and employed residents. The typical commute shed around large employment centers has also been suggested as a spatial context for studying jobs-housing balance (Cervero 1986a).
6. Computed from the 1990 U.S. Census, Summary Tape File 3A. Only land areas are included in this calculation; water areas within the boundaries of cities are excluded.
7. J/ER ratios, in and of themselves, are not satisfactory measures of balance in a correlation analysis, since both very low and very high values indicate imbalance. Since a J/ER ratio of 1 signifies balance, a more appropriate measure is to gauge by how much J/ER ratios vary from one in absolute terms (regardless of sign).
8. In 1990, the median single-family house value was $435,000 in Palo Alto and $388,000 in Sunnyvale. This compares to a median value of $250,100 for the entire San Francisco-Oakland-San Jose Consolidated Metropolitan Statistical Area. (Source: 1990 U.S. Census Population and Housing Data, Summary Tape File 3A.)
9. For each city, average commute distances for employed residents were estimated as the sum of straightline distances from the center of the city to the centroid of all traffic analysis zones (TAZs) for which employed-residents made a commute trip, divided by the total commute trips by these employed residents. (The Bay Area has 1,099 TAZs within the 9-county region; conversion tables were used to translate these to census tract geographies.) Average commute distances for workers were similarly estimated, using data from the CTPP Part 2.
10. For each origin-destination (O-D) pair, commute VMT per worker was calculated by dividing the number of workers traveling in each mode by an assumed average occupancy of that mode, then multiplying this value by the average straightline distance for the pair, and summing over all modal categories. This value was then accumulated over all O-D pairs and divided by the total number of O-D pairs, to derive an estimate. The [illegible] categories (and assumed occupancy of each mode) were: drive-alone (1 person), carpool (1.5 persons), vanpool (3 to 10 persons depending on census coding), bus transit (35 persons), and rail transit (subway or commuter rail—400 persons). These occupancy averages were based on empirical averages from the San Francisco region, using primary data from RIDES, Inc. (1994). For the mass transit modes used for any O-D pair, any fraction of the number of workers commuting by transit divided by the assumed occupancy level was rounded up one digit. This approach sought to estimate the number of motorized vehicles involved in the commute of each O-D pair, as a basis for estimating commute VMT per worker.
11. Similar associations were found between the Independence Index and walking (.400) and driving (−.463) modal splits.
12. These high-job-surplus cities also tended to have low rates of internal commuting, as shown in table 2. For this first comparison, San Francisco is omitted as an outlier data case, because, despite having a relatively high J/ER (1.48), it had by far the highest rate of internal commuting in 1990 (Independence Index = 1.23).
13. In addition to San Francisco, Santa Rosa was omitted as an outlier data case for this comparison, since it also had a high rate of internal commuting in 1990 (Independence Index = 0.74), despite being a job-surplus city (J/ER = 1.27).
14. The correlation between J/ER and commute tim[illegible] 0.345. Also, ANOVA comparisons of commuting times were made between these four high-job-surplus cities and a more limited set of "other" cities that were matched in terms of numbers of employed residents and numbers of workers. This more limited set consisted of seven "other cities" (Berkeley, Santa Rosa, Hayward, Mountain View, San Mateo, Concord, and Fremont) that, just like the high job-surplus cities, had between 30,000 and 70,000 employed residents and between 48,000 and 110,000 workers in 1990. Thus, these matches effectively controlled for scale influences. The ANOVA results were comparable.
15. Similar patterns were found between classes of cities and commuting distances; however, relationships were weaker and statistically insignificant. This could be partly because of the use of straightline distances. In that job-surplus cities had relatively higher commuting times than distances as compared to other cities, it follows that their workers averaged slower commuting speeds, possibly because of more localized congestion. This suggests that job surpluses induce high rates of external commuting by automobile, contributing to congestion on major roads leading to employment sites.
16. The strongest correlation between J/ER and modal splits was for carpooling: −.21. Thus, job-surplus cities tended to have relatively low rates of workers who shared rides.
17. These 12 noncontained cities (with Independence

dexes < 0.25) had 692,200 workers in 1990. If these workers averaged a commute VMT per employee comparable to that for their counterparts in self-contained cities (with Independence Indexes > 0.50), then they would reduce their annual commute VMT by: (692,200 workers) x (2 one-way work trips per day) x (2 fewer VMT per worker per day) x (300 work days per year) = 830,640,000 vehicle miles.

18. Estimates of commute distances are based on information provided by workers as to their zip code of residence. Straightline distances are used.
19. Silicon Valley cities include San Jose, Santa Clara, Sunnyvale, Palo Alto, Mountain View, and Milpitas. Oakland-Fremont cities include Alameda, Hayward, San Leandro, San Lorenzo, and Union City. (Source: 1990 U.S. Census Transportation Planning Package, Parts I and II, San Francisco-Oakland-San Jose Consolidated Metropolitan Statistical Area.)
20. Source: 1990 U.S. Census Transportation Planning Package, Part II, San Francisco-Oakland-San Jose Consolidated Metropolitan Statistical Area.
21. Source: 1990 U.S. Census Population and Housing Data, Summary Tape File 3A.
22. The monthly mortgage for the median single-family home, at these terms, would be $2,145. Assuming that 35 percent of gross earnings go toward principal, interest, taxes, and insurance, this would require $6,130 in monthly earnings, or $73,550 per year. This figure does not include additional costs associated with home purchases, such as brokerage and origination fees, and loan points.
23. Straightline distances were measured from the centroid of each city to the centroid of Pleasanton, using the TransCAD GIS package.
24. City-to-city interchanges with fewer than five commute trips were deleted as statistical outliers.
25. The estimated basic model was: $\hat{T}_{ij} = 1.128^{*}(\text{Population}_i^{0.798})^{*}\exp(-0.12D_{ij})$, with an $R^2 = 0.765$.
26. House Bill 3133, 68th Oregon Legislative Assembly.

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Draft Field Area Paper

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Introduction

The traditional concept of the city as the primary location for work, shopping and entertainment and the suburb functioning principally as a place of residence is obsolete. What were formally known as quiet bedroom communities located at the fringe of metropolitan areas have become, in many cases, economically independent peripheral cities that offer the range of services and employment opportunities that were once only available in central cities. The changing functions and spatial character of central cities and their suburbs have engendered new metropolitan forms, transforming what were traditionally monocentric cities into multi-centered regions.

Multi-centered regions provide many different places for people to live and work. In the past, a majority of people lived in the suburbs and commuted into the city during the week. Rush hour traffic going into San Francisco in the mornings would take hours from the emerging suburbs down the southern peninsula. Today, the traffic going in the opposite direction, down the peninsula from San Francisco, is equally congested due to the growth of technology businesses in Silicon Valley – an area that once consisted of quiet bedroom communities.

Over the past few decades, regional governments have considered reducing traffic congestion and improving quality of life through a strategy termed "jobs/housing balance". In essence, this strategy aims to balance the number of jobs and the number of housing units in a geographical area. The underlying notion is that if an area has the same number of jobs and housing units, daily commutes and air pollution will decrease, and quality of life for people will increase. Intuitively, balancing jobs and housing makes sense – wouldn't it be great if everyone lived within walking distance of their work? However, as many researchers have argued, balancing jobs and housing in a specific area does not guarantee less traffic congestion. Factors such as dual wage earner families, frequent job turnover, and housing preference make it difficult for everyone to live and work in the same place.

Nevertheless, Portland's regional government "Metro" is considering using this strategy to quantify subregional demand within the urban growth boundary. This means that Metro may expand the urban growth boundary in areas where subregions need more land to achieve a balance of jobs and housing. Those in favor of this strategy argue that subregions rich in jobs or rich in housing would have more complete communities if land were added to provide more housing or jobs. Opponents argue that using the jobs/housing balance strategy is simply an excuse to open up the urban growth boundary for large lot single family housing.

This paper argues that Metro should not expand the urban growth boundary based on the jobs/housing balance criterion. Past efforts to achieve a jobs/housing balance in the Bay Area and the San Diego region coupled with existing literature on this strategy support the argument that balancing jobs and housing in any geographic area does not mean that people will live closer to work. Both the San Diego Association of Governments (SANDAG) and the Association of Bay Area Governments (ABAG) have attempted to balance jobs and housing in their respective regions. Initial efforts in the early 90s were either met with political opposition or were abandoned based on weak evidence that balancing jobs and housing would not result in less traffic congestion. Today, both regional governments have switched gears and are implementing other ways to reduce traffic congestion. Local and regional plans still strive for a "jobs/housing balance" but the term is used loosely and is not tied to specific strategies such as creating ratios for geographic areas.

Structure of Paper

The introductory section of this paper has touched on one of the factors leading to an imbalance of jobs and housing units in an area – the inherent dynamics of metropolitan growth. The next section further explores factors that can contribute to jobs and housing imbalances. The section also reviews the literature that supports and criticizes the jobs/housing balance strategy as an effective way to reduce traffic congestion. The third section examines ABAG and SANDAG efforts to balance jobs and housing and the outcome of these efforts. Finally, this paper applies the jobs/housing balance literature and the experiences from the Bay Area and San Diego region to the "subregional needs" approach to growth management under consideration in the Portland Metropolitan area.

Existing Literature on Balancing Jobs and Housing

Over the past two decades, researchers have studied the jobs/housing balance approach for different reasons. Most often, the notion of balancing jobs and housing is discussed as a strategy to reduce traffic congestion and related environmental problems. It is also used to alleviate the ill effects of what is termed "spatial mismatch" – when prices or other characteristics make housing in the area unsuitable (either too cheap or too expensive) for the workers who hold jobs there (Giuliano, Small, 1993). Many researchers argue that a jobs and housing imbalance exists because of spatial mismatch. Recently, the jobs/housing balance strategy has been linked with the popular idea of creating livable communities

The 1980's saw a greater increase in the vehicles miles traveled than in the increase of population, workers or number of vehicles, which stimulated the discussion of jobs/housing balance. The literature on jobs/housing balance as a means to reduce traffic congestion is extensive and consists of many opinions. Robert Cervero, a researcher who has followed the jobs/housing balance in the Bay Area for the past two decades, has written several articles that illustrate the connection between this strategy and traffic congestion. In 1989, he developed a model to simulate the relationship between the jobs-housing ratio and regional mobility. In a Bay Area study, he discovered that in areas with more jobs than housing units, the number of walking and cycling trips falls. Even though this relationship is not very strong, he does conclude that one of the effects of jobs housing imbalance is an increase in motorized transportation.

In the same study, he ran a stepwise model testing the relationship of freeway traffic conditions and jobs/housing balance in areas, finding that freeways tend to be most congested around suburban centers with large amounts of office commercial floorspace, high employment densities and large jobs housing imbalances (Cervero, 1996). As expected, dense job areas without housing tend to suffer the worst freeway conditions because everyone is traveling to the same place at the same time. He found that high levels of congestion on connecting freeways correlate with severe jobs/housing imbalance.

Cervero argues that people choose to live far from job centers because housing is more affordable. In close proximity to job centers, there is often a limited supply of housing because land is not zoned for residential use. In what is termed the "fiscalization of land", local governments zone areas as commercial or industrial to reap the tax benefits generated from commercial and industrial lands. Residential zoning requires the government to eventually provide greater infrastructure for public services (such as libraries, schools) in return for fewer tax dollars. Consequences of jurisdictions vying for high-tech projects have been an uneven distribution of industrial and residential growth, creating prosperous corporate centers and bedroom communities (Cervero, 1989).

Exclusionary zoning is another factor that can limit housing production. Local governments use their zoning power to exclude certain land uses because of community pressure. Local residents sometimes protest undesired land uses, such as low-income housing or high-density housing in fear of an increase in crime and traffic congestion. In the 1980s, long time residents prohibited a jobs housing balance effort in the Hacienda Business Park in Pleasanton, California to build 2,000 housing units for some of the 11,000 employees (Peng, 1997). Thus, even if local governments try to encourage greater density housing near jobs, it is often difficult to win acceptance from long-time local residents.

One of the difficulties in balancing jobs and housing is that it is increasingly more common that households consist of two wage earners instead of just one. Cervero explains that families tend to locate closest to the job of the worker who earns more. The second wage earner will then find work nearby. When both wage earners make similar salaries (which is more common today), it is likely that both wage earners will commute because they have opted to live in between both jobs. He notes that in California's Silicon Valley, 57 percent of dual wage earner couples work in different cities (Cervero, 1989).

In 1996, Cervero concludes from another Bay Area study performed in 1990 that even if an area has a jobs/housing balance, "noncontainment" in the area will still result in traffic congestion. A noncontained area has the same number of jobs and housing but people are commuting into the area at the same rate as those who live there commute out (Cervero, 1996). Thus, an area can be perfectly balanced and still suffer the same amount of traffic congestion as heavily imbalanced areas. Cevero argues that differences in worker's earnings and housing prices cause people to look elsewhere for housing. Available housing near job centers may not be suitable for a wide range of buyers. As previously mentioned, a limited supply of housing near job centers increases housing prices which force people to look outside of the area where housing is less expensive because supply is greater.

Levine argues that the potential for jobs-housing balance to alter where people live exists but is clearly limited. Most likely, affordable housing near job centers can influence the location of low to moderate income workers but not the location of medium to high wager earners. He points out that there are not hundreds of thousands of households waiting to reduce their commutes by moving into denser housing near their work (Levine, 1998). Again, factors such as residential location preferences prevent the reduction of traffic congestion. He concludes that reducing traffic entails increasing residential and transportation choices.

Using research that avoided the problems of using pre-defined and arbitrary geographic areas with fixed boundaries (further discussed in the section on problems with the jobs/housing balance strategy), Peng shows that there is a non-linear relationship between jobs/housing balance and commuting patterns in terms of vehicle miles traveled (VMT). As balance increases, one cannot say that traffic congestion will decrease. His study reveals that only in very jobs poor or jobs rich areas does the VMT per capita and trip length change noticeably as the jobs/housing balance ratio changes (Peng, 1997). His findings support those of Cervero's.

Another study examined whether there was a worsening jobs/housing imbalance evident among 30,000 Kaiser Permanente employees over a period of 6 years. During this time, Kaiser Permanente's workforce increased by 40 percent. The study revealed that the average commute times were increasing by about 5 percent per year but this is because of an overall increase in traffic in the Los Angeles region not in the employee's travel distance. The average commute distances of employees actually decreased slightly over this period of time. The study also revealed that the long-distance commuters were more likely to be married, to have children and to be homeowners. While many employees were frustrated by traffic congestion and delay, they were more sensitive to the cost of housing and the quality of communities (Wachs, Taylor, Levine and Ong 1993). The study on Kaiser Permanente employees lends no support to the notion that a jobs/housing balance reduces traffic congestion.

Guiliano and Small studied the Los Angeles commuting pattern in 1980 and concluded that more than half of the commute time in the Los Angeles region is not a function of jobs/housing imbalances even when occupational mismatches are accounted for. In this study, they examined both the sub-area and employment center levels, determining that other factors must be more important to location decisions than commuting cost. These factors may include residential preference, the desire to have space between work and home, dual wage earners and the growing number of non-work trips. Guiliano and Small conclude that policies aimed at changing the jobs/housing balance will have only a minor effect on commuting (Guiliano,Small 1993).

As the literature illustrates, there does not appear to be a strong connection between jobs/housing balance and reducing traffic congestion. Several of the studies suggest that only in an extremely job rich or housing rich area would balancing jobs and housing have an effect on traffic congestion.

Problems Associated the Jobs/Housing Balance Strategy

Balancing jobs and housing is a weak strategy because it is difficult to determine the geographic areas that should be balanced. It is also unclear as to what "balanced" means. In general terms, the definition of jobs/housing balance is comprised of two parts: the jobs/housing ratio and balance. The jobs/housing ratio is defined as the number of employees to the number of households in a geographical area (Cervero 1989 and 1991).

Jobs/ housing balance is achieved when the number of employees in a particular area equals the number of housing units. While there is little disagreement about the calculation of the jobs/housing ratio, it is much more difficult to find consensus on the notion of balance.

The definition of balance according to Webster's New Collegiate Dictionary is "to arrange so that one set of elements exactly equals another". When applying this definition of balance to jobs/housing balance, it presents a problem because there are many ways to arrange the elements. In trying to make two elements equal to one another (jobs and housing) one could arrange them based on metropolitan region, subregion, city, neighborhood or based on another type of arrangement altogether. Metropolitan regions are self-contained economic units and thus are balanced. As part of the urban growth process, Giuliano (1991) notes that population and employment growth at the regional level move toward balance over time, even though residents may work in different counties. Neighborhoods, because they are so small, are almost never balanced. It is unlikely that a neighborhood will have suitable jobs for all of its residents but if it did, it would be very close to a "perfect balance". Sonny Condor writes that, "ideally people would live upstairs and work downstairs. Commuting would involve a trip up and down the stairs." (Conder, 2000).

Furthermore, there is not unanimous agreement on what ratio of jobs to housing should be set as a target goal. A balanced community has been defined as a self contained, self reliant one, within which people live, work, shop and recreate (Burby et al. 1976).Margolis defined jobs/housing balance when the ratio of jobs to housing is between .75 and 1.25 (Margolis 1973). Others contend that it should be at 1.5. Most growth management plans refer to jobs/housing ratios in terms of 1 housing unit for every 1 job.

Disagreement on defining geographic areas and on what ratio of jobs to housing should be achieved make it difficult to win wide acceptance of the strategy as a policy tool.

Research Method

The notion of matching the homeplace to the workplace (balancing jobs and housing) is found in works as early as Ebenezer Howard's Garden Cities. Howard's concept of garden cities consisted of 32,000 people living and working on 1,000 acres of land surrounded by a greenbelt (Hall). While the primary purpose of Garden Cities was to create co-operative commonwealths, it also defined areas where people could live and work without having to travel long distances. The tradition of creating places where people can both live and work, expressed today as "jobs/housing balance", has been a popular concept in planning practice over the past two decades.

To understand how cities are engaging the concept of jobs/housing imbalance, I chose to focus on two regions that have specifically called for jobs/housing balance in regional and local plans: the San Francisco Bay Area and the San Diego region. I began my research by reviewing local and regional plans to see if the notion of achieving a jobs/housing balance was a stated goal. In both the Bay Area and San Diego it appears in the regional transportation and growth management plans. Wile it is very clear that that these two regions value the notion of balancing jobs and housing in an effort to reduce traffic, it is unclear how they will achieve this balance and what the term "balance" means.

The second part of my research consisted of a series of interviews with planners working in the Bay Area, San Diego and Portland areas. From the Bay Area, I interviewed Gil Kelley, the former Director of Berkeley's Planning Department; Deborah Stein, a former planner for Alameda County; Ciel Scandone, Alex Amaroso, and Karl Lisle, planners with ABAG. I interviewed Susan Baldwin of the San Diego Association of Governments for information on the San Diego region. In the Portland Metropolitan Area I interviewed Gil Kelly, now the Director of the Bureau of Planning; Al Burns and Bob Clay, senior planners with the Bureau of Planning; Bob Rindy at the Department of Land Conservation and Development; and Marc Turpel at Metro. In the 1980s and early 1990s, political opposition prevented both the Bay Area and San Diego region from implementing strategies that attempted to alleviate a jobs and housing imbalance. Further realization of the strategy's limitations led to different approaches years later. However, the goal of "achieving a jobs/housing balance" continues to exist in their regional transportation and growth management plans.

Findings

The San Francisco Bay Area

Initial efforts to balance jobs and housing units in the Bay Area in the 1980s were minimal and subsequently unsuccessful. The Association of Bay Area Governments (ABAG) called for balancing housing and employment growth along the Interstate 580 and 680 corridor in the East Bay where several large office complexes had been built. Bishop Ranch in San Ramon contains 6.1 million square feet of office and manufacturing space and employs approximately 28,000 people. Hacienda Business Park in Pleasanton, covering 876 acres, is the largest development of its kind in Northern California. Approximately 290 companies employ 13,500 workers. At the time of these developments, ABAG planners argued for growth management combined with phased infrastructure investments. They pressured local governments to allow for high-density housing development around the office parks to accommodate the employees. Mounting political opposition from residents strongly opposed to high density housing prevented ABAG from carrying out this implementation strategy (Cervero, 1996). As a result, large housing developments with thousands of units were built over the hill from Pleasanton in a leapfrog development pattern that still requires people to drive on the freeway.

In 1992 Bay Vision 2020, a coalition of business and government interests, pushed to form a regional government to set targets for subregional jobs-housing balance. Political opposition and poor marketing led to the initiative's failure in the California legislature (Cervero, 1996).

Thus, in the 1980s, ABAG's strategy was to urge local jurisdictions to build housing in conjunction with the large office and retail development taking place. They did not set specific job and housing targets for local jurisdictions or for the region. ABAG was unsuccessful in urging new housing development at Hacienda Business Park and Bishop Ranch for several reasons. One, they do not have the power to regulate development as their role is limited to an advisory one. "Urging" local jurisdictions to allow high-density housing and persuading developers to build high-density housing is not very forceful. Two, interviews with ABAG planners pointed out that there are major barriers to housing development in California. One barrier is that the public has a negative perception of density. In the case of Bishop Ranch and Hacienda Business Park, nearby neighborhoods protested housing of any type with the new office and retail developments, for fear that more people would result in greater traffic congestion, crowded streets and unsafe conditions.

Another barrier to housing development is Proposition 13, passed in 1978 in revolt against spiraling property tax rates. The proposition locks in property taxes on a home at the time of its purchase. Consequently, housing development is not financially appealing to local and county governments who are more attracted to commercial development. These barriers in addition to rapid growth in the Bay Area during the 1990s have lead to a region rich in jobs and starving for new housing units.

In the 1990s ABAG sought a different approach in directing job and housing growth. During this time, the Bay area experienced phenomenal growth and unprecedented economic prosperity. Exorbitant housing costs have caused lower wage workers to live outside of employment centers, resulting in long commutes. By the year 2005 the population in the Bay Area is expected to grow by 450,000 people, putting an even greater strain on the existing mismatch between the location of jobs and housing. (ABAG, 1997).

In order to respond to the growing population and household growth of the state, and to ensure the availability of decent affordable housing for all income groups, the State of California enacted a law requiring ABAG to periodically distribute the state identified housing need for its region. The Department of Housing and Community Development (HCD) is responsible for determining the regional need. The regional numbers supplied are "goal numbers" and are not meant to match, and often exceed, anticipated growth in housing units. A goal vacancy rate is set by HCD, and then a housing unit need to meet that vacancy rate is derived by assessing potential growth rates (population, jobs, households) and loss of housing due to demolition. ABAG must then distribute their share of statewide need to all jurisdictions within its region (ABAG, 1996).

During a seven-month process, ABAG developed a methodology for distributing the housing need numbers among its members. An ad hoc Housing Advisory Committee made up of elected officials, planners and housing advocates in the Bay Area, determined a methodology which could allocate a "fair share" approach based on household and job growth of the region (ABAG, 1996). Once the numbers are distributed among jurisdictions, they are required by law to incorporate their housing need numbers into an updated version of their general plan housing element.

ABAG's distribution of housing among jurisdictions takes into account growth in terms of both households and jobs. Both job and housing growth are weighted 50 percent (Jobs/Housing Balance adjustment) to determine the share of regional growth to be applied to the regional goal number received from HCD. The methodology is further used to distribute a share of housing to each jurisdiction by income category. This portion of the methodology distributes the share of each jurisdiction's need by moving each jurisdictions income percentages 50% toward the regional average.

The interview with Alex Amaroso revealed that when this methodology was first developed, ABAG used a much larger weight factor for housing than for jobs because they sought to put housing where there was available land. This resulted in a greater number of housing units allocated to areas already rich in housing and less housing units to areas that were housing poor. The weight factors have since been changed to result in a better jobs/housing balance. Using weight factors of 50% for both jobs and housing does not mean that there will be a balance of jobs and housing in Bay Area cities. The planners at ABAG agree that dual wage earners in a household, job-turnover and undefined commute sheds make it difficult to use exact numerical requirements to achieve balance. The weight factor does, however, guide the number of new jobs and housing units for each jurisdiction so that the two are not severely imbalanced.

ABAG planners also agree that allocating housing and jobs to the same areas is not enough to reduce traffic congestion. In addition, to the housing needs methodology, ABAG is emphasizing inter-jurisdictional partnerships and smart growth. In 1998 ABAG developed the Inter-Regional Partnership (IRP) – a partnership between fifteen elected officials representing five counties. Through the IRP, local representatives can bridge jurisdictional boundaries to forge cooperative solutions to shared problems including: the geographic separation of housing and employment, mounting traffic and air pollution, and growth. The IRP recently developed an action plan which includes an action item that monitors changes in the inter-regional jobs/housing relationship at regular intervals, and works with the councils of governments to collect and integrate important data sources. It suggests that that the IRP meet periodically to review changes and trends in the jobs/housing relationship. Alex Amaroso said that the IRP is a fairly new concept and that they had not begun to implement the action items.

The partnership did, however, produce a paper in 1998 called "Landuse and the Jobs/Housing Mismatch" in which they discuss the severe jobs/housing mismatch in the Bay Area. The paper argues that an effective jobs/housing balance requires more than simply providing an equal number of housing units and jobs. In order to give people the option of living close to their jobs, it is necessary that a community's housing stock match the economic profile of its workers. For example, if 15% of a community's employees are in low-income professions, then approximately 15% of that area's housing ought to be "affordable" to that group of people. The paper recommends strategies for bringing jobs and housing closer together by creating more housing opportunities near employment centers through identifying vacant and underutilized sites, modifying land use policies and zoning codes, and streamlining the permitting process. It also acknowledges that dual wage earners and job turnover make it difficult to achieve a jobs/housing balance. As a result, they recommend smart growth development in addition to balancing jobs and housing (Inter-Regional Partnership, 1999).

Finally, the transportation component of ABAG, the Metropolitan Transportation Commission (MTC), has started a "transportation for livable communities program" which encourages the location of compact, transit-oriented housing at key transit stops throughout the region. MTC will offer grant money for compact communities in the vicinity of public transit hubs. They offer location efficient mortgages (LEMs) to people who live in more compact communities close to public transit. The mortgages allow them to borrow a greater amount of money to afford a home close to public transportation.

San Diego Region

In the 1970s, San Diego unveiled a growth management strategy to slow growth in the far fringes of the city and to accommodate new development within the urbanized area. An ordinance was adopted in 1970 requiring adequate public facilities concurrent with proposed development. In 1979 they adopted a three-tiered planning area: urban, planned urban, and future urban development. To encourage development in the urban tier, capital improvements are targeted in this area, and development incentives were provided (such as waiving development impact fees). In the planned urban area, impact fees and public facility improvements were required for new development. The future urban area was considered a holding zone and was off limits for urban development for a 20 year period. Before being designated as the future urban area, it allowed low density of one home per 10 acres.

Early on, the program was considered successful as two-thirds of the population growth in a five-year period occurred in the central urban tier, and the population growth in the outer area was only one-third of what was originally projected. In addition, numerous requests to re-classify land in the future urban area for urban use were denied.

In the early 1980s problems surfaced in the implementation of the program. The San Diego City Council began to approve higher densities in the future urban area (the holding zone), which ultimately led to a 1985 proposition that requires voter approval for any higher density urban development in the future urban area. Another problem surfaced in the late 1980s where, following years of rapid growth, it became clear there was a shortfall of over $1 billion in infrastructure costs within the urban tier (where impact fees were not charged and capital improvements were not able to keep up with rapid growth). Lastly, it was realized that a loophole existed with the allowable density in the future urban zone where 4-acre lots are permitted. The area has been developing at very low densities mostly by upper income households who can afford the land costs in the outer tier.

Faced with growing traffic congestion and increasingly important quality of life issues in the early 1990s, SANDAG questioned whether land use elements of local general plans should be amended to include the balancing of jobs and housing in the San Diego region (Baldwin, pg 1). In 1991, they considered jobs/housing balance as one of many potential strategies to reduce traffic congestion and improve air quality. To determine whether the jobs/housing balance strategy would create better quality of lives for people by reducing traffic congestion, SANDAG used empirical data from two studies. Initially, SANDAG staff proposed to analyze jobs and housing using the region's metropolitan statistical areas (MSA), however, the technical committee felt that the MSA is too broad of an area and that the jobs and housing balance questions would be more appropriately addressed within the context of transportation corridors. Staff then developed twelve geographic transportation corridor zones (TCZs) which follow the region's freeway and transit system, showing meaningful labor market areas for analyzing the region's jobs and housing balance (SANDAG, 1991).

This first study measured the impacts of balancing job and housing location on the region's transportation system, air quality and energy consumption. It compared the impacts based on the Regional Growth Management Forecast (at the time) and the impacts under scenarios depicting a numerical balance between jobs and housing. The jobs/housing balance for each zone was determined for the years 1986 and 2010. In both years there were, and are projected to be, 126 jobs for each 100 occupied housing units in the region. Using the ratio to define jobs/housing balance, if job and housing location within the region were in balance, each TCZ would have 126 jobs per 100 occupied housing units (Baldwin, Pg. 2).

There was a wide range in jobs/housing balance among the TCZs in 1986. Seven of the twelve zones had more housing than the regional ratio, three had more jobs, and two were very close to being balanced. A preliminary analysis using information from a travel behavior survey conducted by SANDAG in 1986 gave some indication that balancing jobs and housing could have an effect on reducing travel in the region. The average commute trip in the region is 10.8 miles. When commute trips were tabulated by transportation corridor zone, the data indicated that people living in those areas with a higher ratio of housing units to jobs have longer than average commute trips, ranging from 11 miles to 20.1 miles, roughly double the average (Baldwin, APA pg. 2).

The analysis of this study showed that the jobs/housing balance strategy has the potential to significantly reduce energy consumption and demand on the transportation system relative to the jobs and housing distribution portrayed in the Regional Growth Management Forecast. However, the jobs/housing balance strategy and the transportation corridor densities strategies were not included in the Draft Regional Management Strategy because the Technical Committee felt that the research done to date was inconclusive regarding the benefits. They suggested that the following questions be further analyzed: Is there are a causal relationship between jobs and housing and transportation patterns; How should jobs and housing balance be defined; Within what geographic area should jobs and housing units be balanced; How would you monitor the implementation and evaluate the success of these strategies? (SANDAG, Appendix, 3).

In July of 1991, SANDAG responded to the issue of a relationship between jobs/housing balance and travel patterns in a report titled, "The Relationship Between Jobs/Housing Balance and Travel Patterns in the San Diego Region". Multivariate statistical techniques are used to answer two questions. One, do people in more balanced areas drive a shorter distance to work when other factors such as income and multiple worker households are taken into account? Two, what factors are the most important in predicting the length of the commute trip?

The results of this study strengthen the argument that balancing jobs and housing location can reduce commute trip length. Multivariate techniques show that persons living in more balanced communities drive the shortest distance to work regardless of their income, sex, age, housing unit type, industry of work, household size and workers per household. The study also found that jobs/housing balance is the best predictor of commute trip length when looking at the following independent variables: the worker's industry, housing type, sex, household income, age, persons per household, and workers per household. It is important to note, however, that 92% of the variability in commute length is left unexplained by the independent variables (SANDAG Attachment 2).

Ultimately, the technical review committee was not persuaded that housing units and employment forecasts should be adjusted so that all twelve of the TCZs have the same jobs/housing balance. They felt that even though the Travel Behavior Study showed that persons living in more balanced areas drove the shortest distance to work, the statistical relationship is not sufficient to establish causality. They were also unclear how jobs and housing balance should be defined and what geographic areas should be balanced. Alternatively, the Technical Review Committee decided that the Regional Growth Management Strategy should focus on travel time and distance, transit focus areas, and design.

Since the mid 1990s, the goal of SANDAG's Regional Growth Management Strategy has been to maximize access to jobs, shopping and services as measured in travel time, cost and distance-through the distribution and design of future development. They still claim that congestion could be reduced if there were a better balance of jobs and housing in each community but the strategy does not call for a jobs/housing balance based on ratios and defined geographic areas. The plan acknowledges that a better balance of jobs and housing in each community wouldn't solve all of the mobility problems that they face. On average the work trip is the longest daily trip made by a person. However, only 20% of the trips made are during a normal workday, and nearly half of these worktrips are made during off-peak periods. SANDAG states that shopping and service trips must be addressed in addition to worktrips.

Therefore, the Land Use Distribution Element of the Growth Management Strategy recommends that new office, commercial and residential development be focused around rail transit stations and major bus corridors. This will allow for more trips to be made by transit, bicycling and walking. The report does not recommend changing the balance of single family and multiple units which in any case is market driven. Instead, it recommends clustering multiple family units that would be built in communities served by a high level of transit. It also recommends an increase in intensity of employment and both single family and multiple family units in areas with good transit over the next 20 years.

The strategy establishes access objectives for maximum average travel times and distances for work trips and other trips from or to the home (Land Use Distribution Element). The following table consists of the goal travel times and distances to be reached by 2015.

	Travel Time		Travel Distance	
Automobile	Work	Other	Work	Other
	19min	10min	10.6	5.1

According to SANDAG, the achievement of these objectives would ensure that all residents of the region would have equitable access to jobs, shopping and services regardless of where they live. Because of multiple-worker households, home ownership or other factors, some of the region's residents will continue to commute long distances. They acknowledge that individual mismatches of jobs and housing will inevitably occur but at least the opportunity would exist to work, shop and receive services near home.

SANDAG will also be working with areas (cities, counties, and the private sector) around the region that will identify smart growth focus areas throughout the region. They will provide funding incentives for smart growth projects and develop criteria to distribute those funds over which SANDAG has distribution.

The Portland Metropolitan Area

The Portland Metropolitan area is considering using the concept of balancing jobs and housing to determine the need for additional land within the urban growth boundary. In 1994 Metro Council adopted the 2040 Growth Concept and the Urban Growth Management Functional Plan which outlines planning policies for local governments to use to achieve the 2040 Growth Concept.

Through a public involvement process, people agreed on a growth concept that encourages growth in centers and corridors with increased emphasis on redevelopment within the urban growth boundary. The urban growth boundary will only be expanded if "need" for additional urban land is demonstrated. The key to this growth concept is mixed-use urban centers. These include regional centers serving large market areas outside the central city, small town centers with local shopping and employment opportunities and central city, the region's employment and cultural hub. Metro will strive for a balance of jobs, housing and urban amenities so that a greater number of transportation trips can occur without using a car. In addition to this goal, Metro states that another goal is to seek jobs/housing balances by regional sub-areas in efforts to achieve better jobs/housing ratios around the region (Metro, 2040 Growth Concept).

In order to achieve these goals, Metro developed a periodic review workplan that analyzes the region's need for buildable land and produces a set of policy choices. It confronts a tough dilemma facing the region: how can work commutes be reduced while still protecting farm and natural resources land? (Burton, 2000).

Task 1 of the workplan analyzes the next round of 20 year land needs and urban growth boundary amendment decisions. Task 2 of the plan looks at the "subregional need" for housing and jobs, ensuring "complete communities" (as acknowledged in the 2040 Growth Concept and the Regional urban Growth Goals and Objectives) in different parts of the region. Task 2 will identify policies regarding the subregional analyses such as jobs/housing balance and economic development goals. It will also apply regional growth management policies to quantify subregional demand for housing and jobs, based on policy factors. The policy factors may include: equitable distribution of jobs, jobs/housing balance, income, investment, tax capacity and affordable housing, and reductions in vehicles miles traveled per capita (Metro Periodic Review Work Program Summary).

Metro is in the process of figuring out how to quantify subregional demand based on the policy factors above. Once this has been accomplished, they will use this demand to determine whether there is a need for expansion of the urban growth boundary.

Analysis

Based on existing literature and the experiences of the San Diego and Bay Area regions, Metro should not use jobs/housing balance as a criterion for expanding the urban growth boundary. Several reasons point to this recommendation. In a paper titled, "Can We Say Goodbye to Jobs/Housing Balance?" Sonny Condor gives a good example of the strategy's limitations. In December of 1999, several Washington County areas were studied under this subregional need process. Jobs/housing ratios were calculated for the Washington County town centers and regional centers.

Based on these calculations, Condor points out the arbitrary nature of area selection, whether for town centers, regional centers, or subregions, when computing jobs/housing ratios. Similar to the traffic commute zones calculated by SANDAG, calculating ratios based on town and regional centers does not take labor sheds into account. In his paper, Conder illustrates that the regional center ratios for Beaverton (jobs poor) and Hillsboro and Tigard (jobs rich) can easily be tweaked by assigning geographically borderline town centers to different regions. The result would create jobs rich ratios in Beaverton and less jobs rich areas in Tigard and Hillsboro (Condor, pg 6).

Condor's example illustrates the arbitrary nature of defining geographic areas for creating a balance of job and housing. Geographic areas may be balanced or unbalanced depending on how they are defined. The city of San Jose in the Bay Area argues that they are jobs poor and should not be allocated a large number of future housing units. It is true that there are more housing units than jobs in the city of San Jose, however, immediately next door is Silicon Valley – the most jobs rich area in the nation. More housing in San Jose would provide the much-needed housing for the region. San Jose uses the jobs housing balance theory to their benefit by arguing that they need more jobs (which brings the city more money than housing). From a regional perspective, the Silicon Valley area needs more housing not jobs.

As the literature and SANDAG experience illustrate, planners who have done sophisticated jobs-housing balance modeling come away from their analyses with few answers to the problem. Members on the Technical Committee at SANDAG dismissed their study because the numbers were not strong enough to show causality among jobs/housing balance and traffic congestion. The case for jobs/housing balance having an influence on commuting has not been made on a metropolitan wide basis. Peng and

Cervero conclude that the jobs/housing imbalance strategy may only improve traffic congestion in areas that are severely imbalanced.

Instead of applying specific jobs/housing ratios to subregions, ABAG and SANDAG are looking at new ways of reducing traffic congestion. Similar to the transit oriented development of Orenco Station in Portland, ABAG and SANDAG are focusing on mixed-use housing along rail lines to increase the use of public transit. Both regions are also building inter-regional type partnerships to foster regional collaboration, realizing that efforts to balance jobs and housing must come from all jurisdictions. They are providing more types of housing in employment areas so that homebuyers have greater options. They are also providing incentives such as location efficient mortgages which reward people with low-interest loans if they live near public transportation. SANDAG is setting commute targets for the year 2015 which they expect to meet through the implementation of the strategies discussed above. Planners interviewed at ABAG and SANDAG both said that it was too early to tell if these new "smart growth" strategies would be successful in reducing traffic congestion and improving quality of life.

Conclusion

This study concludes that there may be more profound factors in addition to fiscal and exclusionary zoning, dual wage earners, and political pressure that prevent the balance of jobs and housing from being a successful tool. The inherent dynamics of metropolitan growth, frequent job changes, and residential preference may have an even greater influence on where people live and work.

Anthony Downes describes "the inherent dynamics of metropolitan growth" as the clustering of firms near the center of an area in order to provide greatest access to all points within the area (Downes, 1992). Clustering of firms such as in the Silicon Crescent in Washington County, Oregon promotes collaboration and creates a large labor pool of skilled workers. Clustering also improves the efficiency of their interactions enabling them to pay higher rents for the land that is now in great demand. Unable to afford the cost of land in the job center, homeowners look to the outskirts for housing.

As the entire area grows, affordable homes are found farther out from where jobs locate. The high-technology centers in Washington County, Oregon and Silicon Valley, California serve as two examples. Certain jobs, such as those associated with daily services, relocate closer to housing, partially correcting the imbalance. However, because travel costs are still less than land, this imbalance continues. Many workers in Contra Costa County, California have been forced to commute 100 miles per day because the price of homes in the area have increased significantly due to the clustering of the high-tech industry (Cervero, 1989).

An increase in job turnover rates also prevents people from living and working in the same area. It is not unusual for people to switch jobs every couple of years, especially those working in the high-tech industry. Moving is expensive and inconvenient for families. Those workers who lived close to their job three years ago may live an hour-commute away from a different job today.

Finally, not everyone wants to live near his or her workplace. Many Americans still want their share of the American Dream. They enjoy commuting in a luxury automobile from their home situated on a half acre of land out of the noisy, polluted city where they work. A study performed in 1994 among Orange County, California residents living on the edge of the county revealed that 23% chose the area because of its remoteness. 21% of the respondents chose the area because it offered new homes (Giuliano 1995).

The research in this study reveals that attempts to move people closer to their work must involve more than balancing the number of jobs and housing units in an area. It must also address more than matching housing type with market demand. As long as people move from job to job, desire large homes in low-density areas, and insist on driving alone, they will sit in traffic. If Metro is going to expand the urban growth boundary to allow particular subregions a balance of jobs and housing units, it will not result in less traffic congestion. It is unlikely that quality of life will improve. Inevitably, the subregion will once again succumb to local governments that aggressively pursue businesses and the inherent dynamics of metropolitan growth. Allowing the subregion more land simply pushes this process along.

These conclusions may be oversimplified, however it is clear that regional governments are focussing their efforts on transit oriented development and inter-regional partnerships as a much more effective strategy of reducing traffic congestion and improving quality of life than balancing jobs and housing.

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Gil Kelly / Portland Bureau of Planning
Deborah Stein / Portland Bureau of Planning
Bob Clay / Portland Bureau of Planning
Al Burns / Portland Bureau of Planning
Mark Turple / Metro
Bob Lindy / Department of Land Conservation and Development
Alex Amaroso / Association of Bay Area Governments
Ciel Scandone / Association o f Bay Area Governments
Susan Baldwin / San Diego Association of Governments
Karl Lisle / Association of Bay Area Governments

2040 Centers

Tax Base Comparison

By City

Taxable Values

Jurisdiction	PSU 2000 Estimated Population	Single Family Residential	Multi-Family Residential	Non-Residential	Total	Residential Val / Per Capita	Non-Residential Val / Per Capita	Total Val / Per Capita	Valuation Split Residential	Valuation Split Non-Residential
Washington County	427,500	$17,082,514,960	$2,111,921,790	$8,358,565,370	$27,553,002,120	$44,899	$19,552	$64,451	70%	30%
Clackamas County	332,850	$14,671,954,709	$1,179,886,781	$5,179,448,061	$21,031,289,551	$47,625	$15,561	$63,185	75%	25%
Multnomah County	653,800	$23,416,258,204	$2,068,602,530	$10,276,840,365	$35,761,701,099	$38,980	$15,719	$54,698	71%	29%
Metro	1,248,548	$50,404,435,809	$5,228,474,606	$21,973,735,092	$77,606,385,887	$44,558	$17,599	$62,157	72%	28%
Inside Metro										
Lake Oswego	35,035	$2,796,946,563	$176,060,496	$437,215,061	$3,410,222,120	$84,858	$12,479	$97,338	87%	13%
Wilsonville	13,615	$596,031,914	$146,694,546	$572,927,945	$1,315,654,405	$54,552	$42,081	$96,633	56%	44%
Happy Valley	4,345	$386,594,239	$0	$24,296,846	$410,891,085	$88,975	$5,592	$94,566	94%	6%
Tigard	38,835	$1,734,721,974	$220,201,340	$970,397,650	$2,925,320,964	$50,339	$24,988	$75,327	67%	33%
Tualatin	22,535	$853,187,407	$151,168,665	$663,399,501	$1,667,755,573	$44,569	$29,439	$74,007	60%	40%
West Linn	23,380	$1,486,453,387	$69,903,914	$79,838,233	$1,636,195,534	$66,568	$3,415	$69,983	95%	5%
Rivergrove	310	$21,063,350	$0	$0	$21,063,350	$67,946	$0	$67,946	100%	0%
King City	2,125	$115,953,300	$12,341,510	$14,131,500	$142,426,310	$60,374	$6,650	$67,024	90%	10%
Hillsboro	72,630	$1,982,940,440	$428,441,890	$2,065,224,850	$4,476,607,180	$33,201	$28,435	$61,636	54%	46%
Durham	1,570	$63,532,200	$7,830,670	$23,631,000	$94,993,870	$45,454	$15,052	$60,506	75%	25%
Beaverton	70,230	$2,557,785,117	$540,888,560	$1,090,184,030	$4,188,857,707	$44,122	$15,523	$59,645	74%	26%
Portland	513,325	$18,582,046,189	$1,620,186,140	$8,487,624,580	$28,689,856,909	$39,356	$16,535	$55,890	70%	30%
Gresham	86,430	$2,575,708,250	$383,342,070	$1,524,137,846	$4,483,188,166	$34,236	$17,634	$51,871	66%	34%
Milwaukie	20,250	$684,240,387	$75,838,786	$284,831,218	$1,044,910,391	$37,535	$14,066	$51,601	73%	27%
Sherwood	10,815	$472,113,580	$8,856,500	$74,601,570	$555,571,650	$44,472	$6,898	$51,370	87%	13%
Maywood Park	770	$38,000,880	$152,820	$91,150	$38,244,850	$49,550	$118	$49,669	100%	0%
Oregon City	24,940	$814,868,921	$98,123,608	$239,801,513	$1,152,794,042	$36,608	$9,615	$46,223	79%	21%
Troutdale	14,300	$472,401,260	$30,626,010	$144,268,190	$647,295,460	$35,177	$10,089	$45,265	78%	22%
Forest Grove	17,130	$418,303,360	$67,809,270	$216,504,430	$702,617,060	$28,378	$12,639	$41,017	69%	31%
Wood Village	2,915	$61,607,330	$2,765,920	$53,336,760	$117,710,010	$22,083	$18,297	$40,381	55%	45%
Gladstone	12,020	$385,343,839	$43,030,692	$49,561,873	$477,936,404	$35,638	$4,123	$39,762	90%	10%
Fairview	6,885	$164,315,670	$26,156,750	$46,989,430	$237,461,850	$27,665	$6,825	$34,490	80%	20%
Cornelius	8,715	$210,154,430	$14,053,510	$53,345,950	$277,553,890	$25,727	$6,121	$31,848	81%	19%
Johnson City	340	$152,089	$4,857,459	$2,765,502	$5,009,548	$14,734	$8,134	$14,734	100%	55%
Outside Metro										
Canby	13,170	$431,009,641	$57,685,689	$117,103,672	$605,799,002	$37,107	$8,892	$45,998	81%	19%
Sandy	5,655	$179,739,433	$17,304,496	$62,621,001	$259,664,930	$34,844	$11,074	$45,918	76%	24%
North Plains	1,780	$55,257,536	$2,568,500	$20,205,140	$78,031,176	$32,487	$11,351	$43,838	74%	26%
Estacada	2,200	$59,556,872	$6,774,878	$24,792,536	$91,124,286	$30,151	$11,269	$41,420	73%	27%
Barlow	125	$3,943,898	$0	$1,023,158	$4,967,056	$31,551	$8,185	$39,736	79%	21%
Banks	1,580	$51,892,580	$1,710,290	$5,108,210	$58,711,080	$33,926	$3,233	$37,159	91%	9%
Molalla	5,720	$146,898,065	$16,054,386	$30,410,638	$193,363,089	$28,488	$5,317	$33,805	84%	16%
Gaston	620	$12,094,450	$252,070	$1,711,590	$14,058,110	$19,914	$2,761	$22,674	88%	12%

Sources:

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Multnomah County - Multnomah County Assessment and Taxation, January 24, 2001
Washington County - Metro Data Resource Center tabulation of Washington County Assessor's database dated 12/00

Notes:

- For aggregation purposes in Washington and Clackamas Counties residential properties were deemed to be any property with a PCA code of 100 - 199 (Single Familiy Residential), 400 - 499 (Tract Land) or 700 - 799 (Multi-Family), all other properties with PCA codes less than 900 were deemed to be commercial.
- Residential property totals include single-family and Multi-Family Residential values
- County totals include unincorporated areas