Internal Working Paper

Consultant Scope of Work for the Transportation and Land Use Model Integration Program

Prepared for

Transportation Development Branch
Oregon Department of Transportation
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The technical work program is broken into three phases, as described in the Request for Proposal. A design and review of the recommended modeling approach will be carried out in Phase I. The work will begin with a review of the literature, tools, and methodologies that are germane to the development of an integrated statewide land use and transportation model. The planning and modeling requirements of the ODOT and other governmental agencies in Oregon will be assessed as well. Based on the knowledge gained during these tasks, a conceptual design of the modeling system and supporting tools and databases will be prepared, and presented to the Oregon DOT (ODOT) staff, Modeling Steering Group, and Peer Review Panel. Based upon their comments, detailed management and technical work plans for Phases II and III will be jointly developed by the consultant and ODOT staff.

The development of functional, prototype models, databases, and supporting tools will be carried out in Phase 2. We will focus primarily on the land use and transportation models. While we will develop interim socioeconomic models, further work will need to be accomplished when additional funding becomes available. While the precise structure and functional form of the model have not been defined, we have outlined a recommended approach to model development. Some elements will of course change during the Phase I work, but we suggest the approach outlined is both workable and practical. The resulting products will produce credible and useful results. They will, however, only be first generation products, and as such further work will be required to enhance and refine them to meet the ultimate requirements. Our goal is to produce products which are highly extensible, allowing for incremental development as data and funding become available.

The study will conclude with a look to the future in Phase 3. A number of institutional and implementation issues will be examined. Definitive recommendations will be provided for further development work. Particular attention will be paid to the challenges of maintaining the momentum built during the project. An examination of the institutional settings in which statewide modeling will take place will be accomplished, including an examination of the resources required to sustain the continued development of the databases, the models, and the linkages with other modeling efforts in Oregon. A prototype study of the land use allocation model will be undertaken. The utility of the land use allocation model to real-world applications will be critically assessed, and recommendations presented for the full implementation of the statewide model.

The following general conditions will apply to the work performed under this contract unless otherwise agreed upon by the consultant team and the ODOT project manager.

All documents and reports prepared for ODOT will be in Microsoft Word (version 6.0 compatible) format. The submittal of final copies of documents and reports will consist of:

1. 1 camera ready original,
2. 20 copies of the original document or report, and
3. An electronic copy of the original in Microsoft Word 6.0 or compatible format.

All documentation provide for and or posted on the ODOT home page will be in Adobe Acrobat Pro (version 2.1 compatible) format. All presentation materials will be the property of and submitted to ODOT during the course of this contract.

All software programs and applications developed during the course of this contract and specific to this contract will be the property of and submitted to ODOT including all source code and documentation.

Phase 1: Prepare Comprehensive Literature and Policy Review and Refine Phase II Work Plan

The integrated modeling system will be designed and extensively reviewed during Phase I. During this Phase of the project a detailed review of existing efforts and programs, applicable data, techniques, and tools will be undertaken, as will an examination of ODOT planning and modeling requirements. The consulting team will prepare a conceptual design of the integrated model and its supporting databases and tools, and develop detailed project management and technical work plans to complete the project. The conceptual designs will receive a broad review from the ODOT, Modeling Steering Group, Peer Review Panel, and the user community in Oregon. The exposure of the conceptual design to such a wide audience can be expected to produce important feedback to the study participants about the validity of the approach and utility of the products.

Task 1.1: Presentation to ODOT and State Executives

Discussion: PB's principal-in-charge will assist ODOT staff in the presentation of the study goals and objectives, technical approach, schedule, and products to Oregon's Community Solutions Team (CST) including the Governor or his representatives.

Products:

1. Presentation materials.
2. Attend 4 June 1996, Community Solutions Team meeting and make presentation as directed by the ODOT project manager.
3. Document suggestion and recommendations generated by this presentation concerning this project.

Schedule: This task will be completed by 30 June 1996.

Task 1.2: Prepare recommendation for Peer Review Panel

Discussion: ODOT staff in consultation with the Modeling Steering Committee and the consultant team will assemble a panel of experts from the Pacific Northwest and other regions and institutions from throughout the United States to provide review of the technical direction of this contract. The Peer Review Panel will advise ODOT, the Modeling Steering Committee, and the consultant on the content of the project and provide a broad technical perspective on the relationship between the model development work being conducted in the State of Oregon and research and development of similar modeling efforts nationally and internationally. The Peer Review Panel will participate in periodic review of the products, procedures, processes, models, applications and documentation being developed as part of the Transportation and Land Use Model Integration Contract. The Peer Review Panel will report directly to the ODOT project manager and will also meet and advise the Modeling Steering Committee and consultant with reviews of the progress being made on the project, and technical recommendations related to forecasting, database development and modeling.

Products:

1. Recommendations for membership of Peer Review Panel
2. Provide direct travel expenses for Peer Review Panel Participants

Schedule: The recommendations for the Peer Review Panel will be completed by 30 June 1996. Compensation for the travel expenses will be distributed throughout the contract period as applicable and will be completed by 30 June 1996.

Task 1.3: Review the literature, methods and tools applicable to statewide and substate land use-transportation modeling

Discussion: Phase 1 will begin with a review of the methodological work completed in statewide modeling to date. This review will include but not be limited to the full range of modeling activities encompassed in Phase 2 of this project. In addition to statewide and regional socioeconomic, land use, and transportation models, the review will also include supporting areas as well, such as geographic information systems, travel surveys and innovative data collection techniques, and advances in urban transport and land use modeling. Given the time and budgetary constraints, these reviews will not be exhaustive. Rather, by focusing on the stated goals and objectives of the Oregon DOT and the expertise of the study participants, the scope and depth of these reviews will be tailored to relevant and interesting contributions to the state of the art in statewide modeling.

Product:

1. Draft technical report covering four areas of research noted below
2. Draft report to be distributed to study participants for review and comment.
3. Final report incorporating pertinent study participant comments. Final report to be distributed to study participants six to eight weeks in advance of the recommendations workshop in Task 1.6.
4. Full results of literature searches will be posted on the ODOT home page

Report Contents:

1. A thorough search of the literature in statewide modeling. Several on-line databases to conduct searches of the literature on the full range of topics described above. Candidate databases include the Transportation Research Information Service (TRIS) and Impala. A number of bibliographic archives on the Internet will also be searched, to include NetEc (Network of Economics working papers) and CARL (Colorado Alliance of Research Libraries), to name but a few. The Internet archive sites are especially fertile grounds for identifying work in progress that would not be found through searches of traditional databases, and also includes material about on-going projects that rarely enter into academic literature. The literature search will not be limited to only electronic information. The consultant team will also draw from the vast collections of printed materials as well.

   The results from these searches will be quite voluminous. The results of these searches will serve as resources, from which the more germane citations will be created for inclusion in the Task 1.3 report. The full searches, however, will be available to all study participants in electronic format via the ODOT home page.

2. Work in progress in the topic areas will be assessed through contacts with a variety of sources. Of particular interest will be on-going efforts funded by the National Cooperative Highway Research Project (NCHRP) and U.S. Department of Transportation. These contacts will extend beyond the United States, to include such groups as the Economics and Social Research Council (U.K.), the European Community Transport Forum, and the Canadian Council on Scientific and Industrial Research (CSIR).

3. A review of current and obsolete statewide models, identified through the literature, work in progress reviews, and personal knowledge of the study participants. Included in the review will be work underway in various states and countries, with a special emphasis on those models which integrate two or more of the three major modeling areas envisioned in Oregon. Where possible, interviews with the sponsors of failed or obsolete statewide models, particularly those undertaken by state DOT's, will be obtained to attempt to discover the reasons

why the models were abandoned (Kentucky and Wisconsin are examples of states which have abandoned or scaled back seemingly successful efforts).

4. Currently available modeling packages will be briefly assessed to determine their suitability for use in Oregon. A number of integrated land use-transportation models are in existence (such as TRANUS and MEPLAN) which are plausible candidates for adaptation, as well as several transportation packages which are flexible enough to permit tight integration with GIS packages (such as EMME/2, STAN, and TransCAD). GIS is the platform upon which we envision arraying these various models; a review of GIS platforms in use by the Oregon DOT and metropolitan planning organizations (MPOs) within Oregon and the coordination between them will be profiled. A brief review of GIS tools with potential for use in the Phase II will be conducted as well.

Schedule: All products and work will be completed by 31 May 1996. The ODOT review and subsequent editorial changes will be complete by 30 June 1996.

Task 1.4: Review the policy and data requirements of the OTP, TPR, and Oregon State Benchmarks

Discussion: The purpose of this task is to place the development of statewide models firmly in the context of statewide policies and plans. Since the need for new model systems is clearly the result of over five years of state and regional policy planning, it is essential that all these plans be reviewed. The PB team will identify clearly the matrix of policies, data requirements and model development needs on which future task work will build. The models built during this project will serve as tools not only for forecasting, but also as policy analysis tools.

ODOT staff and members of the PB team have already participated in a brief and productive review of these three documents. Together they have developed a preliminary list of relevant sections from each. This inventory of policies is not necessarily complete. However, as the discussion below will may clear, even in its preliminary form it hold clear implications for both the data needs and model development needs associated with this project.

The three key documents whose policies and goals will shape the statewide model development effort are the Oregon Transportation Plan, the State's Transportation Planning Rule and the State's Benchmarks. The Transportation Plan was the first of its kind in the United States to link explicitly transportation and land use issues and to provide a multi-modal context for statewide transportation plans and project development. The State's Transportation Planning Rule is the administrative regulation which structures the implementation of the State's transportation planning goal, a foundation of Oregon's land use planning system. The Transportation Planning Rule defines the characteristics of acceptable transportation plans, establishes standards for transportation system performance, and requires explicit linkages between local land use and transportation planning processes. It is in the process of influencing an entire generation of local planning in Oregon. The Oregon State Benchmarks establish measurable performance standards for a wide variety of state and local government activities. They represent goals toward which Oregon's officials can work to achieve their common vision of Oregon's future.

The PB team will conduct a full, detailed review of these key planning documents in order to identify all relevant policies, goals and standards. For each goal or standard so identified, the team will describe the data needs associated with its measurement and the kind of model suited to its estimation. The PB team will review the results of this analysis with the project's Peer Review Panel and Modeling Steering Group. For those policies, goals or standards not suited to inclusion in the statewide model development process, the team will identify the nature of further

research required for the University partners, in order to make sure that future policy decisions can be informed by the best available knowledge.

Work on this task will necessarily focus not only on transportation related policies and standards, but also on others as well. As indicated, for those standards or policies which are not easily modeled, the team will identify related work which needs to be performed.

Both in work performed for the State of Oregon, its cities and counties, and for agencies around the United States, the PB team has already been involved in planning, research and model development linked to all the policy requirements identified in the Land Use Modeling Workshop held in November. For these policy requirements, the PB team has undertaken the following applications, which will be further examined in this Task:

User Pricing of Transportation Facilities
Full Costs and Benefits of Transportation Systems
Constraints of Acknowledged Comprehensive Plans
Changes in Accessibility
Interurban and Rural Mobility and Goods Movement
Level of Service Requirements
Redevelopment
Public Facilities Plans
Automobile Use and Reliance
Consistency of Land Use and Transportation Plans
Evaluating Land Use Alternatives

Product:

1. Draft technical report reviewing key state plans, goals, and requirements to establish a foundation for model development work in Oregon
2. Final report incorporating editorial changes and pertinent comments
3. Post final report on ODOT home page for this project when available

Schedule: All work and the technical report will be completed by 31 May 1996, with ODOT review and subsequent editorial changes completed by 30 June 1996.

Task 1.5: Review current GIS programs and activities underway in Oregon

Discussion: There are several on going efforts in Oregon dealing with GIS applications. These programs and activities may play a vital role in the development of the GIS application and data sharing involved in this contract. Examples of such programs and effort are the Oregon Road Base Information Team (ORBIT), Oregon GIS Plan, and the GIS coordination work of the State Service Center for Geographic Information Systems. The consultant team will investigate GIS and data sharing efforts in Oregon and determine how the work of this contract will supplement or draw from the existing effort.

Product: Technical report reviewing and recommending ways to coordination and cooperate between the existing GIS and data sharing efforts in Oregon and the needs and direction of the Transportation and Land Use Integration Program.

Schedule: All work and the technical report will be completed by 31 May 1996, with ODOT and DAS review and subsequent editorial changes completed by 30 June 1996.

Task 1.6: Prepare recommendations for developing the databases, models and forecasting methods to be used in Phase 2

Discussion: Equipped with the knowledge gained in the previous two tasks, the consulting team will evaluate and recommend the alternative designs for databases, models, and tools that will be developed during Phase 2. These efforts will obviously be an important element of Phase 1, defining the character and work elements of the remainder of the project. The recommendations will address a number of areas:

1. A conceptual design of the three component models (socioeconomic, land use, and transportation) will be prepared. Recommendations about the model structure, theoretical bases, methodological framework, resource requirements, and analytical capabilities will be provided. Of particular concern will be the interaction between the models. Consideration will also be given to the implementation environment, encompassing such issues as the user interface and software implementation.Information sharing will again be an important consideration, especially the interaction between statewide and urban land use and transportation models.

2. The major data elements underlying the various models will be identified, and recommendations presented for their acquisition, storage, retrieval, and reporting. A distinction will be made between data required for model development and testing, and those required for model application. The Consultants will evaluate and make recommendations regarding the establishment of links to data stored elsewhere which can be accessed when needed vs., the collection and storage of data within the statewide modeling framework. A significant consideration will be the effort required to update database under different architectures. A second important consideration will be the design of an open architecture. Under such a scheme users will be able to access data for use in different computing environments. Information sharing is an important goal of the ODOT, and will be addressed in these recommendations as well.

3. It is anticipated that a geographic information system (GIS) will be used as the platform on which the various models will be integrated. Most if not all of the data will be exchanged between the various models (socioeconomic, land use, and transportation) within the GIS. The GIS will also serve as the interface between the integrated modeling system and other database systems, such as the Oregon Highway Management System (OHMS) and existing ODOT, DAS and local agency databases. It will also provide the logical point of entry by external users, such as the metropolitan planning organizations. The recommendations advanced by the consulting team will include different options of GIS platforms, considerations for data organization and access methods, and recommendations for maintaining compatibility with the various existing databases (both spatial and tabular), and data sharing. Recommendations will also be made for establishing an information sharing network for this project. The review of alternatives will first focus on using ODOT's WWW home page. If this alternative is selected the home page will continue to reside on ODOT server and maintenance will be ODOT's responsibility. All documents posted on the ODOT home page will be in Adobe Acrobat Pro (compatible with version 2.1) format. This work will need to meet ISB protocol and be coordinated with ODOT's Information Systems Branch.

4. Recommendations will be provided concerning the need for ancillary tools, such as database access and query programs, data translators, and statistical analysis tools. Recommendations will be made regarding specific programming tools, languages, and standards for software which will be developed by the study participants.

5. Anticipated data collection activities in Phase 2 will be identified. Recommendations will be made as to the survey scope, methodology, sampling, and schedule. The need to obtain information about vacation travelers has already been articulated by the ODOT staff. Additional information on truck flows in Oregon will probably be required as well.

Products:

1. Draft technical report detailing study design encompassing each of the areas identified above. Attention will be paid to the specification of the model elements and their data requirements. The report will recommend hardware and software applications based on model specification, data requirements, and ODOT travel forecasting resources. This report will include an Information Needs Analysis (INA) for Phase 2 work.
2. Final technical report including an INA incorporating editorial changes and pertinent comments from the workshop participates during Task 1.8.
3. Draft technical report recommending primary data collection activities required to complete Phase 2 activities. This report will include an Automation Implementation Plan (AIP), and will outline the justification and anticipated uses of the data, proposed survey methodology, sampling frame, and brief discussion of the analysis methodology and the impact upon the project of not obtaining the data.
4. Final technical report including an AIP incorporating editorial changes and pertinent comments from the workshop participants in Task 1.8.
5. Both final reports will be posted on the ODOT home page for this project when available

Changes or additions to the Phase 2 work plan necessitated by the conceptual designs recommended in this task will be documented and reported, and will become important inputs to the design of the Phase 2 refined work program and schedule in Task 1.10.

Schedule: The work and products will be completed by 21 June 1996. The ODOT review and subsequent editorial changes will be completed by 19 July 1996.

Task 1.7: Develop project review and management plan.

Two types of project reviews will be carried out during this contract: informal, internal reviews conducted by the consultant project manager and task leaders, and formal periodic reviews which will also include ODOT staff and others they may invite. Both types of reviews will focus not only on work underway, but also work about to commence. Key management priorities that will be embodied within the management plan include:

1. Monthly project management reviews with the ODOT staff and Modeling Steering Group will be conducted. These reviews will be structured, with formal and written presentations by the consultant project manager and task leaders. Included in these reviews will be discussions of deliverable products, problems encountered with the work plan, and other issues affecting the technical work. A workshop structure will be used, and the meetings are expected to last 1 to 2 days each. These meetings will also be extended to a third day on a quarterly basis to meet with the Peer Review Panel.

2. The Internet will be use to exchange information, data, and ideas about technical issues, especially those work elements that transcend different models. ODOT's dedicated World Wide Web (WWW) home page will be used to centralize documents and data. Working papers, draft copies of deliverable products, GIS files, programs, and other information will be immediately available to all study participants. It is anticipate that this mechanism will form the basis for information sharing among project participants and Oregon transportation planners.

3. PB's project manager will obtain briefings and discuss progress with task leaders and the ODOT project manager on a weekly basis, and conduct an internal project review at a minimum of every two weeks with the principal-in-charge.

Other project management issues, such as hardware and software purchases, will be addressed as part of this management plan. The consultant team will define discrete interim work products within each task. These elements will form the basis of our reporting requirements, as they will each have a budget, schedule, and completion date. The task leader will be responsible for the completion of all elements within their task. For each element underway or starting before the next review, the following items will be covered:

1. The objectives of each Element, to ensure that the client, project manager, and task leader each understand what is required, when, in what format, and within what budget. Elements will typically not involve more than one firm.
2. Identify the resources others must furnish to the element(s). The status of the input products will be identified, and action plans agreed upon to resolve problems obtaining key resources.
3. The current status of the work, to include anticipated completion date.
4. The status of deliverable items for the element (and Task). If products have been delivered to the client or others for review, the nature of comments received and their impact upon the product and schedule completion date will be determined.
5. Problems and exceptions to the detailed technical work plan will be discussed and resolved.
6. A description of the work to be completed before the next review will be agreed upon.

For informal, internal reviews, the project manager will briefly note these items in a worksheet. These reviews will be conducted weekly in person or by conference call. On a monthly basis, normally one week prior to the monthly review with ODOT staff, task leaders will submit written progress reports for each element. These will be used both as written documentation of work completed for billing purposes and for discussion at the review meeting. The project manager will be responsible for promptly notifying the ODOT staff of problems and the recommended resolution.

A formal project review will be conducted on a monthly basis with the ODOT staff and consultant project manager, and task leaders and university researchers as appropriate. The reviews will follow the same format as the internal reviews, but will include the written reports previously prepared by the task leaders. The project manager will consolidate and forward them to the ODOT staff in advance of the meeting. It is anticipated that the most of these meetings will take place in the ODOT offices. The goal of these meetings will be to ensure that the project is proceeding as planned and to discuss, resolve, and implement solutions to problems identified by the study participants.

Product:

1. Draft technical report documenting project review and management plan addressing the above mentioned items and including sample formal and informal progress reports, billing procedures, and schedules.
2. Final technical report incorporating editorial changes and pertinent comments

Schedule: The work and product will be completed by 14 June 1996. ODOT review and comments will be furnished by 21 June 1996, with all editorial changes completed by 30 June 1996.

Task 1.8: Present Recommendations to ODOT, Modeling Steering Committee, and Peer Review Panel

Discussion: A two day workshop will be conducted to discuss the recommendations of Task 1.6. The workshop would take place approximately three weeks after the draft technical report submittals from Task 1.6.

The workshop will be conducted in a lecture-discussion format. ODOT and consultant project managers will review the project goals and objectives, and outline the overall recommended approach. The consulting team members will then provide a 45 to 90 minute overview of the proposed approach to each of the Tasks in Phase 2, followed by a 60 to 90 minute moderated discussion led by the ODOT and PB project managers. It is anticipated that all of the Phase 2 Tasks will be covered on the first day.

On the morning of the second day, break-out groups will meet to discuss each task in Phase 2. The groups will be self-selecting based on personal interest. The goal of these groups will be to identify deficiencies or questions about the recommended approaches, identify possible alternative approaches, and to suggest areas of additional research and development. The session leaders will report the findings of each group in a closing plenary session. It is suggested that the Peer Review Panel be convened shortly after the workshop to report their findings to the consultant team and ODOT staff.

It is anticipated that some attendees will respond only after reflecting for several days on what they've heard at the workshop. A means will be provided for workshop participants to communicate their feedback to the ODOT project manager, who will distribute the feedback to the study participants. The consulting team will incorporate the appropriate workshop suggestions and Peer Review Panel comments into the management plan and refined Phase 2 work plans. The consulting team will discuss the suggestions internally, and advise the ODOT staff of changes in the Task 1.6 recommendations prompted by the workshop feedback.

Products:

1. Organize and lead two day workshop.
2. Prepare work shop presentation materials and accommodations
3. Prepare a report of workshop proceedings, focusing on the recommendations from workshop participants.
4. ODOT will be responsible for providing the workshop facilities and making presentations as indicated and agreed upon with the consultant team.
5. Prepare final workshop proceedings and post on the ODOT home page

Schedule: The workshop will be held during the week of 15 July 1996. Peer review committee and modeling steering group meetings will be scheduled by ODOT to correspond with the workshop dates. The workshop proceedings will be completed by 26 July 1996. ODOT review and editorial changes will be completed by 9 August 1996.

Task 1.9: Presentations to Oregon Transportation Commission (OTC) and ODOT Policy Team

Discussion: The PB project manager and or principle-in-charge will assist ODOT staff in the presentation of the projects goals and objectives, technical approach, schedule, and products to the OTC and ODOT Policy Team.

Products:

6. Prepare presentation materials, or modify Task 1.1 presentation materials
7. Attend August 1996 OTC meetings and make presentation as directed by the ODOT project manager.
8. Attend June or July 1996 Policy Team Meeting and make presentation as directed by ODOT project manager.
9. Document suggestions and recommendations generated during the two presentations concerning this project

Schedule: To the maximum extent possible, these meetings will coincide with other trips by the PB project manager to the ODOT to reduce the cost such meetings. The presentation for the OTC will occur August 1996, and the presentation to the Policy Team will be arranged for June or July 1996.

Task 1.10: Refine work program and schedule for Phase 2

Discussion: A three day workshop will be held two to four weeks after the Task 1.8 workshop. It will include the ODOT staff, PB principal-in-charge and project manager, task leaders, and other consulting team members as needed. If possible, the group will also include university researchers expected to play a role in the project. The group will review the significant comments and recommendations received at the Task 1.8 workshop, Task 1.1 and 1.9 presentations and the consulting team's responses to them.

Once the revised recommendations are understood and agreed upon, the group will proceed to translate the conceptual designs from Task 1.6 into a refines Phase 2 work plan. Elements of work will be identified, their interdependencies to other tasks and elements identified, and priorities assigned. The consultant task leaders will develop schedules, budget allocations, identify required resources, and assign staff members to the work.

Products:

1. A draft refined work plan and schedule for Phase 2 including milestones for ODOT, Modeling Steering Committee, and Peer Review Panel review.
2. Final work plan and schedule for Phase 2 incorporating editorial changes and pertinent comments
3. ODOT approval of final work plan and schedule
4. Post final work plan and schedule on ODOT home page for general distribution.

Schedule: The workshop and subsequent work on the revised work plan and schedule will be completed by 31 August 1996. The ODOT and other participants comments and subsequent editorial changes will be completed by 30 September 1996.

Phase 2: Forecasting, Data Base, and Land Use Model Development Program

The modeling processes designed and approved in Phase 1 will be developed during Phase 2. While the primary focus will be on the land use and transportation models, adequate attention to the other components will be essential. The tasks will be conducted in parallel to the maximum extent possible, reducing the time required to complete this Phase.

Task 2.1: Project Management, Task Coordination, and Information Sharing

Discussion: The project review and management plan developed in Task 1.7 will be followed through the duration of Phase 2, is directed towards insuring that appropriate management and reporting methods are used to track the project. The timely identification and resolution of technical difficulties, unforeseen design issues, and scheduling conflicts will be essential if the project is to be completed on time and on schedule.

This task will be closely tied to Task 1.10 (Phase 2 refined work plan). The work plan will describe in detail the work to be accomplished in Phases 2 and 3. The emphasis of this task will be to implement several project management methods and to constantly monitor the progress of the project. The ODOT and consultant project managers will review the progress of the project, assess changes in technical approaches, and track schedule conformity.

Product: Project reviews as outlined in the Task 1.7 management plan

Schedule: This task will be conducted during the duration of this contract.

Task 2.2: Prepare Statewide and Substate Economic and Demographic Forecasts

The purpose of this task will be to develop a set of models and databases that will allow ODOT and others to generate up-to-date economic and demographic forecasts on an ongoing basis, as well as preliminary 25 year forecasts for immediate use. The forecasting work will be coordinated with the work of other agencies, including the Office of Economic Analysis, ODOT's planning section, Metro, the Portland State University Center for Population Research and Census, the Port of Portland, and the Bonneville Power Administration.

Element 2.2.1: Develop Statewide Economic and Demographic Forecasts

Discussion: This element will adapt the currently approved statewide economic forecast and develop a set of preliminary, long-run economic and demographic models to disaggregate them to the level required by the statewide model. The consultant will work closely with the Office of Economic Analysis in the Department of Administrative Services to develop a logical and consistent extension to their model. The goal in this Element will be to develop a model which will extend, not replace, the current statewide economic forecasts, thereby maintaining consistency with economic forecasts used by other state agencies and initiatives.

Since employment by industry and total population are of insufficient detail to support the statewide travel and substate and metropolitan land use models, the state economic model will need to be extended to produce an appropriate level of disaggregation. Since total employment at the state level will be projected by industry, it is important to develop a set of industrial categories that meet the full set of objectives of the models to be developed within this project. A certain grouping of industries may be appropriate for the land use models, a slightly different set for trip generation rates, and a slightly different set for predicting commodity flows. The first step in the development of the model will be the identification of an appropriate clustering of industries that will support all of these modeling needs, without adding unnecessary detail. It is expected that roughly 20 industry categories may be needed, and will be based on 2-digit SIC groupings.

The logic of the land use models will be based on the treatment of the locational choices of the decision-making units for employment: businesses. The recommended approach is the development of a procedure to relate the employment totals generated from the core economic model to a distribution of business establishments by industry and by size (number of employees). The data for this is readily available from the County Business Patterns for an adequate historical period to support analysis of long-term trends and relationships in the size distribution of busi-

ness establishments by industry. Businesses by size and industry will be more meaningful units of observation for land use modeling than are employment counts by industry: businesses choose locations, and types of space, based on their industry and size, and on the accessibilities of alternative locations, and the cost of space. In addition, businesses by industry and size are more meaningful for developing trip generation rates, and for evaluating travel demand management strategies.

For population, it is clear that certain population characteristics are very influential in predicting location choices. These include race/ethnicity, age or stage of life cycle, and income or socioeconomic status. The cohort-component procedures currently developed by the Department of Administrative Services provide a widely-used approach to reconcile employment forecasts with population by age and sex through induced migration. It is proposed that this approach be extended to provide the additional attributes needed for the land use models. The core economic model will produce per capita income forecasts and total population. These will be used as control totals. A cohort-component technique is proposed to capture trends in the aging of the population.

Ultimately, the unit of observation for the location behavior in the land use models should be the household, not the individual (as in the case of businesses and employment), since location choices by definition affect the entire household. What will be needed for the land use models, then, is a distribution of households by size, income, and age of head. This demographic procedure will take the age/sex population cohorts and allocate them into a household distribution by type for each forecast year, based on historical trends in these relationships estimated from an analysis of the Public Use Microdata Samples from 1970, 1980, and 1990.

Products:

1. Draft technical report describing the statewide economic forecasts developed by the Department of Administrative Services and a model to extend them to the level of detail required by the statewide model
2. Statewide economic and demographic forecasting models
3. Draft model user guide documentation
4. Draft Technical report describing the models and their derivation, data requirements, and application environment
5. The source code, executable modules, and user documentation of software developed during this task
6. Final technical reports and documentation incorporating editorial changes and pertinent comments from ODOT, DAS, Modeling Steering Committee, and the Peer Review Panel
7. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: The work and products will be completed by 11 October 1996. The reviews and editorial changes will be completed by 8 November 1996.

Element 2.2.2: Estimate Substate Demographic Composition and Economic Activity

Discussion: For the larger substate regions the consultant team will develop economic forecasting models specific to the regions. These regional models will be calibrated to the statewide model. To satisfy the needs of the commodity flow and land use models, substantially more detail will need to be provided at the substate level than at the statewide level. The substate models also will allow numerous variables to be constrained or adjusted manually to allow the inclusion of assumptions about the effects of local economic development and land use policies and to test the effects of alternative views of a region’s future. The product developed will allow ODOT and others to specify a wide variety of policy assumptions in the economic and demographic models

and test their effects throughout the integrated system of travel demand, commodity flow and land use models.

The substate economic forecasts will predict the distribution between substate regions of businesses by industry and size, and households by size, income, and age of head. These allocations will then serve as control totals for the metropolitan land use models, and as inputs to the statewide travel and commodity flow models. To support the use of these data in the statewide travel and commodity flow models, the classification of industrial groups discussed in Element 1 will need to consider the degree of goods and people transport between industries.

Several approaches will be considered for the disaggregation of the substate economic models. Among these are a class of models developed outside the U.S. that use input-output and discrete choice, such as TRANUS and MEPLAN. As an alternative, it may in fact be more productive to develop a substate economic model using a parallel approach to that proposed for the metropolitan land use model. This would be a discrete choice model, where the choice is made between a relatively small number of substate regions or metropolitan areas, and utility functions are defined for businesses and households that reflect statewide accessibility patterns, as well as the economic and demographic size and composition of each region, and key policy relevant variables such as the availability and price of land, housing, and commercial space. This approach would allow for an analysis of changes in policies such as urban growth boundaries or transportation investments on the relative attractiveness of Portland and other regions for businesses and households of different types.

An initial list of the variables that might be included in business utility functions would be:

The business mix in related industries (identified from analysis of I/O tables)
Accessibility indices to businesses by type
Accessibility to key transportation nodes (e.g. ports, airports, rail)
Accessibility to key production inputs or raw materials (e.g., lumber)
Household mix by type
Accessibility indices to households by type (representing labor and market)
Costs and availability of land, housing, and commercial space

The household utility function is likely to overlap heavily with this list of variables in the business utility function, although industrial groupings would be broader, more detail would be desired on the mix of population, and access to inputs would not be needed.

A significant feature of this modeling approach is the potential to tightly integrate it with the statewide travel and metropolitan land use models. Use of logit techniques in trip distribution and mode choice, and potentially trip generation, suggest a strong symmetry and integration. Since this approach is an extension of that proposed for the metropolitan land use models, it could be implemented as a nested logit model, where the attractiveness of alternatives within a metropolitan area can be fed back into the substate level choice process. An application of this would be that if a metropolitan area's policies significantly increase land costs or availability, it should influence the relative attractiveness of the metropolitan area compared to other substate regions, thereby shifting growth to or away from it.

Products:

1. Substate Demographic composition and economic activity models
2. Draft model users guide documentation
3. Draft Technical report describing the models and their derivation, data requirements, and application environment

4. The source code, executable modules, and user documentation of software developed during this task will be provided as well
5. Final technical reports and documentation incorporating editorial changes and pertinent comments
6. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: The work and products will be completed by 31 December 1996. The ODOT review and editorial changes will be completed by 31 January 1997.

Task 2.3: Develop Models and Forecasts of Statewide Transportation Flows

A statewide travel demand forecasting model will form the second major component of the Transportation and Land Use Integration Program. This task and the GIS and land use model developments in Task 2.4 will be the primary focus of the Phase 2 work. The goal is to produce a set of functional prototype models which by design are both highly integrated with the other models and databases developed in other tasks, as well as extensible. The importance of the latter attribute cannot be overstated; the products of these tasks must accommodate both near- and long-term improvements to the models and their underlying data.

The statewide transportation models developed during this task will address both passenger and freight flows. While many modeling techniques will be common to both groups of travelers, there are enough behavioral differences to dictate separate but parallel modeling streams on the demand side. This approach will allow the continued development of the passenger and commodity flow models at different paces, consummate with ODOT priorities and data availability. It is anticipated that the supply side modeling and the primarily network assignment will be carried out together. The consultant will take advantage of recent advances in multiclass network assignment techniques, which permit the simultaneous assignment of heterogeneous groups. This will allow each group to perceive the network differently, while still accounting for the interaction between them as well as their cumulative effect on the network.

The first generation transportation models will initially operate on a limited intercity network. The network will initially consist of the roadways on the National Transportation Network, plus others deemed significant by the ODOT. The network will extend at this level of detail beyond Oregon into adjacent states, and will become progressively more abstract with distance. A similar hierarchical scheme for other modal networks will be developed. Each named place or activity center (such as an intermodal terminal outside of an urban area) will be represented as a single node in the network. Unlike traditional transportation networks, these activity nodes will serve as both zonal centroids and intersection nodes. While the Portland metropolitan region may be represented as a cluster of activity nodes, most cities will be represented as a single node.

Forecasts of intercity passenger and freight flows will be completed during this task. The forecasts will be for both the base year (model validation) and for a future year chosen by the ODOT staff. The primary output of the transportation forecasts will be intercity flows by mode of transportation and user class (automobiles, buses, trucks, etc.), as well as outputs from the transportation model which will be used by other models and other ODOT systems (such as the OHMS). The interaction with the socioeconomic and land use models will be an important part of the forecasting process, as will the demonstration of visualization and query of transportation modeling results using graphical displays.

Element 2.3.1: Intercity Passenger Travel Demand Modeling

Discussion: A number of statewide models have been developed over the past 20 years, most of which are based on the four-step modeling process used in urban area models. These models

have met with only limited success. The traditional gravity model formulation has proven especially problematic. Moreover, many of the assumptions underlying the traditional four-step process do not apply in intercity travel, such as the effects of congestion (rarely a factor in rural areas), perception of out-of-pocket costs, modal substitutability, and factors considered in mode and route choice.

As noted in Phase 1, this contract will consider a wide range of approaches to modeling passenger flows. These will be discussed at length with the ODOT staff, Modeling Steering Group, and the Peer Review Panel. Experience to date in other statewide modeling efforts suggest an approach built upon discrete choice modeling techniques for estimating the demand for intercity passenger travel. The consultant suggests implementing logit models of trip generation, destination choice, and mode choice. Depending upon the data sources employed in model estimation, these steps may be combined (e.g., a combined model of trip generation and destination choice). This approach is attractive for many reasons. It will permit the specification of models which closely parallel those in the land use model. By employing many of the same behavioral assumptions and data, a degree of consistency between the models not heretofore achieved will be possible. The parallel structures should also reduce model development time and cost, as the idiosyncrasies and flaws exposed and corrected in one model will presumably eliminate such behavior in the other, as well as providing an excellent starting point for model calibration.

Several aspects of discrete choice models make them useful in the context of today's policy analysis questions. A considerable amount of research is on-going in the area of activity-based travel demand forecasting, models of which are being postulated as logit formulations. The eventual transition to such models will be far less burdensome, since their predecessors will be of the same formulation.

An average weekday passenger trip generation model will be developed from a variety of data sources. Like most states, Oregon does not have intercity travel survey data from which to construct models. A significant new source of data—the 1995 American Traveler Survey (ATS)—will shortly become available. The ATS is a nationwide survey of approximately 80,000 households being conducted by the Bureau of the Census for the U.S. Department of Transportation. The survey measures intercity passenger flows by all modes, and will provide data on trip and traveler characteristics. While the ATS may not provide all of the data required for model estimation, it will go a long ways towards improving intercity trip generation estimates. These data will be examined in order to determine their utility in statewide modeling and the potential for fusing them with data from other sources, such as the public use microsample (PUMS) data.

The definition of trip purposes to be examined in the passenger model will depend on a number of factors, to include the structure of the ATS data and considerations about compatibility with the current urban models. Based upon work elsewhere, it is anticipated that between three and five trip purposes will be defined. These will likely include at a minimum the following purposes:

1. *Commuting trips*, which are very similar to home-based work trips in urban areas. These trips typically account for about one-third of all intercity trips by auto. In addition to the ATS, useful data about these trips are also available from the statewide Census Transportation Planning Package (CTPP). These trips may be split into home-based and non-home-based if sufficient data are available.
2. *Recreational and vacation travel* is often another large component of intercity travel, and has markedly different characteristics than other trip types. This will probably prove significant in Oregon. A review of the available data will be necessary to determine whether additional data will need to be collected.

3. *Personal business*, which includes shopping, school, medical or other professional service, and other types of trips. In their recent work in Michigan, Costinett and Outwater found that these trips differ little in their incidence from urban areas. But in other models with fewer competing metropolitan areas surrounded by large rural areas (New Mexico and New South Wales), Donnelly has found that such trips to the hub city are a large portion of the intercity flows. This trip purpose can be split between home-based and non-home-based generators, although the distinction is often not as important in intercity travel as it is in urban models.

There is strong rationale for combining the trip generation and destination choice components of the model. In most intercity trips, the decision to travel is coupled with the decision about where to travel to. Indeed, the reason for traveling is determined by the activity at the destination end (camping in a park, visiting a client, etc.), for which there is no substitutable destination choice. Most often such decisions are insensitive to all but profound changes in network impedance This type of behavior is better handled using discrete choice or simulation models.

The destination choice model will be calibrated using data from a variety of sources. For commuter travel, the statewide CTPP is perhaps even more useful here than in trip generation. It contains trip interchange information at the level of named places and counties. The ATS will provide valuable data on interstate movements for all trip purposes, which should prove invaluable for handling through trips

The use of partial and fully synthetic matrix estimation techniques based on link volumes will be an important tool in model development. Through the judicious selection of reliable count sites and limited origin-destination information, a matrix of total daily trips by mode of transport can be derived. From these full matrices the through trips (deduced from the ATS data factored to counts at the state borders) and commuting trips (from an expansion of the statewide CTPP data) can be subtracted, leaving the intrastate non-commuting trips. The resulting matrix could then be used to help calibrate the remaining trip purposes. When better data become available (such as through a survey of vacation travelers), the same technique could be used to further decompose the synthetic matrix into its component trip purposes, resulting in better destination choice models. A carefully constructed roadside survey at key locations in the state conducted early in Phase 2, could provide sufficient information to develop robust destination choice models. Such a survey may be the most cost-effective means of obtaining reliable origin-destination for model estimation.

Products:

1. First generation Intercity Passenger Travel Demand Model
2. Draft model users guide documentation
3. Draft Technical report describing the models and their derivation, data requirements, and application environment
4. The source code, executable modules, and user documentation of software developed during this task
5. Final technical reports and documentation incorporating editorial changes and pertinent comments
6. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: The work and products will be completed by 31 March 1997. ODOT review and subsequent model, software, and documentation modifications will be completed by 31 May 1997.

Element 2.3.2: Intercity Freight Travel Demand Modeling

Discussion: Freight models generally fall into one of two categories: *commodity flow models* and *truck models*. Commodity flow models are typically regional or national in scope, focusing on the flow of goods between markets. The flows are mode-abstract and measured in tons or dollars, a reflection of the fact that they are more commonly used in economic analyses than transport sector appraisals. Truck models, on the other hand, do not differentiate between commodities (or commodity families). They are usually no more than an estimate of truck movements as a function of land use variables, and as such are not very useful in policy analyses or long-term forecasting.Neither type of model is entirely satisfactory for use in statewide planning, although a commodity flow model is more closely related to the type of integrated models being considered for Oregon.

The consultant propose to implement a hybrid of these two separate modeling frameworks; the resulting model will be called a *freight model* so as to not confuse it with the other types. Such an approach has been successfully implemented in Michigan, New Mexico, and New South Wales (Australia). This approach is based upon earlier work on a national commodity flow model in Canada, which formed the basis for the development of STAN, a multicommodity, multimodal modeling companion to EMME/2. In this hybrid approach, the flow of commodities are modeled using economic data. Models of trip generation, destination choice, and mode choice similar to that specified for the passenger model will be developed. These models will also be discrete choice formulations, and may also be combined where advantageous. Using seasonal adjustment factors derived from Oregon data and truck survey data, these flows (measured in tons) will be converted to truckloads for network assignment.

Whereas passenger movements are differentiated by trip purpose, commodity flows are broken down into commodity families with similar economic and transport characteristics. In order to make the modeling process tractable, the model will include between 10 and 20 commodity families. The development of a truly multimodal model is beyond the resources of this project. The consultant proposes to restrict the model developed during Phase 2 to the trucking mode, as its impact on the roadway system is usually of primary concern to public sector transportation planners. Note that the modeling framework established during Phase 2, however, will be truly multimodal and provisions to add rail, air, and waterway modes will be made for future expansion. The expansion of the model to cover other modes will be possible with the development of modal networks and their connections to the highway network, collection of mode-specific survey data, and refinement of the mode choice model.

The primary source of data for the freight models will be the 1993 Commodity Flow Survey (CFS), conducted by the U.S. Bureau of the Census. The survey describes the commodity, vehicle, and shipper characteristics of the mining, manufacturing, and selected wholesale sectors of the economy. Origin-destination data by mode of transport and commodity will be available at the state level beginning this summer. The CFS was a major improvement over previous surveys, and will provide essential data for model development. Because the CFS data will only portray flows at the state level, data from input-output accounts are used to allocate movements to zones within the state. This approach complements the proposed economic and land use models, in that the same input-output structure will be used elsewhere in the modeling chain. By virtue of design, the data required for the freight model is the same used in all other components of the integrated statewide model. The CFS and input-output data must be supplemented with truck survey data collected in Phase 2. These data will be collected at several weigh stations in Oregon, and will include weight, vehicle classification, commodity classification, and origin-destination data. Because all commercial vehicles must stop at weigh stations, these surveys will be easy to design and quite inexpensive to conduct.

Products:

1. First generation Intercity Freight Travel Demand Model
2. Draft model users guide documentation
3. Draft Technical report describing the models and their derivation, data requirements, and application environment
4. The source code, executable modules, and user documentation of software developed during this task
5. Final technical reports and documentation incorporating editorial changes and pertinent comments from ODOT
6. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: The work and products will be completed by 31 March 1997. ODOT review and subsequent model, software, and documentation modifications will be completed by 31 May 1997.

Element 2.3.3: Transportation Supply Modeling and Model Integration

The demand for passenger and freight movements will be modeled separately, but combined together for network assignment and evaluation. Both automobiles and trucks will be assigned using the same network. By employing a multiclass assignment technique, they can use separate link cost functions (reflecting their differing perceptions of the same network) while being simultaneously assigned. This will allow their cumulative effect to be assessed while maintaining the ability to analyze the flows of each class separately.

The transportation models will be tightly integrated with the other components of the statewide model at several levels. All components will use the same network, and exchange network-level attribute data via their representation in GIS. Changes in network attributes made by the transportation supply models, for example, will become immediately available to the other components. The land use model will directly use the network assignment results to calculate accessibility measures, which will be used by both the land use and transportation models (remember that accessibility will be a variable in both the destination and location choice models). Several key inputs to the transportation models will likewise be generated by the land use and socioeconomic models.

The statewide transportation model must also interact with the metropolitan area models. Some of these interactions are relatively straight-forward. For example, the intercity flows produced by the statewide model can be directly used as replacements for the internal-external and external-external trips in the metropolitan areas. The metropolitan models can in turn provide measures of impedance through cities, which will be important attributes of the activity nodes in the statewide transportation model. The statewide land use and socioeconomic models in the near-term can provide a consistent basis for estimating growth in the inputs to the metropolitan area trip generation models, and in the longer-term become fully integrated.

Products:

1. First generation Statewide Transportation Supply Models
2. Draft model users guide documentation
3. Draft Technical report describing the models and their derivation and specifications, data requirements, application environment, calibration and/or estimation, model and data integration
4. The source code, executable modules, and user documentation of software developed during this task

5. Final technical reports and documentation incorporating editorial changes and pertinent comments from ODOT
6. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: The work and products will be completed by 31 May 1997. ODOT review and subsequent model, software, and documentation modifications will be completed by 30 June 1997.

Task 2.4: Develop Models and Adapt Geographic Information Systems to Conduct Land Use Allocation and Policy Analysis

The Travel Model Improvement Program (TMIP) has a track examining the state of the practice in Land Use Modeling, and the National Association of Regional Councils (NARC) recently issued a report containing some recommendations for land use model improvement. In addition, an NCHRP project 8032(3) entitled “Integrating Land Use Planning with Multimodal Transportation Planning,” being conducted by Sam Seskin, Genevieve Giuliano, and Paul Waddell, has been reviewing the state of the practice and assimilating feedback from MPOs and state DOTs. There appears to be some consistency in the priorities for improvement in land use models desired by MPOs, which include:

1. Integrate land use models with GIS.
2. Develop better techniques for assessing the accuracy of the forecasts.
3. Develop more efficient software and easier user interface.
4. Develop more policy-analytic capabilities in the models.
5. Better integrate the land use, transportation, and environmental models.
6. Develop a calibration procedure over a longer period of time.
7. Improve the employment data used in the modeling process.
8. Addition of land market behavior, consideration of housing stock and values, land consumption and pricing, and policies affecting development.
9. Clearer behavioral foundations.
10. Test alternative models developed outside the U.S.

The goals and objectives of the ODOT Transportation and Land Use Model Integration project will require that most of these recommendations made in the TMIP and NARC reports be realized within the design of the land use models.

Element 2.4.1: Develop Specifications and Working Prototype of a Statewide Land Use-Transportation GIS Application

Discussion: GIS should be considered an integrating infrastructure to link land use and transportation planning and modeling. GIS will be used to collect, store, retrieve, disseminate, and display transportation and land use information, and will play an analytical role in the integrated transportation and land use models. The need to assimilate and exchange information among state agencies, MPOs, counties, and cities within the state also suggests investigating the use of the Internet as a core integrating technology.

The following factors need to be considered in developing this part of the work program:

1. The need to be sensitive to the current data availability, computing configuration, staff and expertise within all participating agencies.
2. The opportunity to use all relevant GIS data investments completed or underway within participating agencies, including ODOT and DAS GIS resources, and those of MPOs, Counties, and municipalities.

3. The need to review and recommend standards, guidelines, and approach for improving GIS implementations as MPO staff time, resources, and interest permit and pertains to this contract.
4. The need to create a systematic infrastructure for data sharing pertinent to this contract.
5. The need to develop linkages between Intergraph and Arc/Info systems maintained by ODOT and other participants.
6. The need to provide adequate documentation, through both printed and electronic forms of Metadata, following FGDC guidelines consistent with current state practices. (

An emphasis of this work will be to development an application to access existing GIS data. An initial assessment of the kinds of data to be examined for use in supporting the policy analysis and land use modeling in this work scope can be broken down by geographic level:

ODOT GIS Data

Statewide transportation networks (highway and rail) and attributes
Ports, airports
Administrative boundaries, including metropolitan areas, MPO boundaries, counties and cities
National parks and forests
Principal tourist destinations
Indian reservations
Other public lands
Hydrography
Annotation

Metropolitan GIS Data (gathered from participating agencies)

Detailed transportation networks (highway and transit) and attributes
Administrative boundaries (as above)
Census geography to census block level
Longitudinally consistent census tracts (aggregated to adjust for 1970 to 1990 splits or boundary changes)
Traffic analysis zones, and aggregations of these zones
Land use polygons (if developed by MPO, not needed where parcel data exists)
Parcel or tax lot data (in GIS where available, otherwise - tabular county tax roll records) including land use, area and value; improvement type, quantity, value and age
Land use plans, zoning, and other land use restrictions
Business establishments (or major employers)
Planned developments (projects in some stage of approval, permitting, or platting)

The prototype application will be developed within an MPO area or super region such as the Willamette Valley for which assimilation of the key data layers is feasible within the scope of this project. The area will need to be selected also on the basis of the needs to prototype the land use model. It is anticipated that there will be wide variations in data availability, and in the format, scale, and accuracy of those data. Some of the effort in this task will need to be devoted to recommending common standards for this program, and to developing automated procedures to facilitate the exchange of data between the primary electronic formats in use by participants.

Products:

1. Draft technical report detailing the design of the land use and transportation modeling GIS application environment and data dictionaries
2. Prototype GIS environment, and supporting databases with user and appropriate Metadata documentation

3. All source code and executable modules including those for linking to internal and external databases and models
4. User documentation of software and software applications developed during this task
5. Final technical reports and documentation incorporating editorial changes and pertinent comments from ODOT and other participating agencies
6. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: The detailed GIS application design will be submitted for ODOT, DAS, and participating agencies review by 30 August 1996. The review will be completed by 30 September 1996. The prototype GIS application will be completed and implemented by 30 November 1996. The comments and changes will be completed by 31 December 1996.

If an additional information needs assessment for this task is required, it will be submitted to ODOT by 30 August 1996. Assuming that approval of the information needs assessment is obtained by 30 September 1996, the prototype GIS application will be completed and implemented by 31 December 1996, with ODOT review completed by 31 January 1997.

Element 2.4.2: Develop a Prototype Land Use Allocation Model

Discussion: The third goal of the Oregon Transportation and Land Use Model Integration Program focuses the model development effort for improved policy analysis, impact assessment, and on monitoring progress toward adopted policy goals:

> Goal # 3: Establishing Methods for Evaluating Key Policies in the Oregon Transportation Plan, Implementing the Statewide Transportation Planning Rules and Assessing Progress Made Toward Achieving Goals Implicit in Oregon's Statewide Benchmarks.

This is a feature that distinguishes this scope of work from the traditional land use modeling effort that is intended primarily to develop baseline forecasts with some sensitivity to transportation improvements, and is consistent with the TMIP and NARC recommendations. It is quite clear that traditional spatial interaction land use models such as DRAM/EMPAL will be inappropriate to conduct the policy analysis this project requires. The policies to be analyzed are likely to have a combination of direct and indirect influences on development and travel. The direct effects will include those factors that the policies have an immediate influence on. The indirect effects are those which the policies influence via secondary outcomes of the direct effects. The following provides an initial draft of these direct and indirect effects:

Direct Effects of Transportation and Land Use Policies:

- Cost of land development, redevelopment, ownership
- Availability of land for development
- Restrictions on density or land use
- Transportation infrastructure supply, transit level of service
- Cost of travel
- Cost and availability of parking
- Vehicle maintenance requirements
- Cost of vehicle ownership and operation

Indirect Effects of Transportation and Land Use Policies:

- Prices of land, housing, and commercial space
- Probability of land development and redevelopment
- Nature of land use, mix of land uses
- Density of land development
- Relocation of households
- Relocation of businesses
- Distribution of population and employment

Travel patterns by mode
Travel times and levels of service
Air quality

The approach to modeling land use and its interactions with transportation will be guided by the need to 1) inventory the policies identified in Phase 1, and identify the direct effects of these policies, 2) ensure that the land use and transportation models are designed to evaluate the indirect impacts of these direct effects, 3) design evaluation components into the models to allow users to assess both the validity of the results and the predicted impacts of alternative policy scenarios on a range of evaluation measures to be identified in Task 1.6 and 1.4 and the constraints on data availability.

The appropriate type of integration of land use and travel models is to develop the land use models using a discrete choice framework similar to that now frequently used in transportation mode split models, and soon to be adapted to trip distribution. The trip distribution model should, in a truly integrated model system, be completely consistent with the land use model. Use of logit models of location choice allows this integration.

A land use model designed to assess the land use impacts of transportation and growth management policies will need to be constructed such that the sensitivity of businesses, households, and developers to different kinds of accessibilities can be estimated. Rather than assuming that the journey to work of the household head is the driving force in residential location, a more general discrete choice model will be based on a utility function of residential locations that includes accessibility measures to employment opportunities of different types, shopping opportunities, and to recreational and other amenities. A substantial body of research has shown how important the demographic and social composition of neighborhoods are in predicting residential location. In particular, race or ethnicity, age or stage of life cycle, and socioeconomic status or income, appear to be extremely important in residential location. These factors, along with housing availability and cost, provide a reasonably complete context for the residential location decision, and allow analysts to examine the partial effects of changes in the transportation system through the impacts on accessibilities and ultimately on location preferences of households and businesses.

A key innovation of the proposed land use modeling approach will be to deal with land use as an evolutionary, or dynamic process. Housing and nonresidential buildings are semi-permanent features of high durability, and urban development is a marginal process that adds within any time period, an increment to the housing and commercial stock, and accommodates a certain proportion of moves of households and businesses among these structures. Whereas most existing models are calibrated cross-sectionally, the models are used to produce 20-30 year predictions. Almost no effort has been devoted to specifying the dynamic behavior of land use change over time, and into calibrating and validating such longitudinal behavior. It is proposed that at least a 20 year historical period be used to calibrate the evolutionary behavior of land use, and the mobility and location choices of businesses and households. This responds to one of the key TMIP recommendations related to longitudinal application of the land use models.

Summary of Technical Approach to Land Use Allocation Model

The following provides a brief summary of the technical approach proposed for the development of land use models:

1. Design a dynamic, longitudinal rather than cross-sectional model, calibrated with at least 20 year historical period.
2. Separate locational behavior into mobility (whether to move) and location choice (where to move), potentially linked as a nested logit model.

3. Mobility probability is heavily influenced by age, and to a lesser extent income, and household size. It could also be linked to location choice as a nested logit model, since more attractive alternatives could increase the probability of moving. A test of this modeling strategy by Waddell is underway in Dallas and completed in Seattle.
4. Variables in the utility function for location choice will be similar to those listed for the substate economic model, except that the scale of the accessibility terms will be intraurban, and economic and demographic mix within zones is likely to be more prominent, as will land, housing, and commercial space costs and availability.
5. Disaggregate households and businesses to differentiate locational preferences and travel behavior differences.
6. Incorporate multiple measures of accessibility into location choice utility functions, to test policy impacts.
7. Incorporate an endogenous land market, with quantities and prices of land, housing, and commercial space accounted for. Businesses and households choose locations and types of structures, and their utility is influenced by accessibilities and prices.
8. Facilitate policy analysis by explicit accounting for direct and indirect policy impacts, with most policies directly impacting prices or restricting alternatives available (e.g. zoning restricts land use alternatives).
9. Link GIS functionality directly into the models consistent with task 1.6, 2.4 and Element 2.4.1. Data management, analysis and visualization will be conducted using GIS.
10. Investigate a framework for electronic communications between ODOT, MPOs, and other state and local agencies.
11. Link substate location models with metropolitan land use models as a nested logit model, allowing either statewide or metropolitan policies to influence the distribution of economic activity within metropolitan areas.

Products:

1. Draft technical report detailing the structure of the land use models, mathematical derivation and specification, calibration or estimation of modeling components, data requirements, and application environment
2. First generation land use model and GIS environment, and supporting databases with user and appropriate Metadata documentation
3. All supporting source code and executable modules including those for linking to internal and external databases and models
4. User documentation of software and software applications developed
5. Final technical reports and documentation incorporating editorial changes and pertinent comments from ODOT and other participating agencies
6. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: The work and products will be completed by 31 December 1996. ODOT review and subsequent model, software, and documentation modifications will be completed by 28 February 1997.

Phase 3: Recommendations for Implementing and Sustaining Statewide Land Use Modeling

Task 3.1: Recommendations for University Research and Staff Training

Discussion: During this task the consultant team in consultation with ODOT will make very specific recommendations for university research involvement. Also, during this task the consultant team will make recommendations on and develop a formal and informal training plan to be implemented during the course of the contract. The models developed during Phase 2 are to serve as the primary hands on training environment for ODOT staff. At the completion of this project ODOT staff will be trained in the development, operations and maintenance of the models. This informal type of training will also extend, but at a lesser degree, to the membership of the Modeling Steering Committee and other applicable staff. Formal class room training will also take place under this contract. During this contract, the consultant team will develop and implement a training plan for ODOT and other participating agencies staff.

The consultant team envisions several kinds of training. These include the use of workshop formats for face-to-face exchange of information at an early stage of this task. In addition, the team envisions the preparation of a written models manual similar in form to that already developed for the travel demand forecasting work nearing completion. Thirdly, the team envisions the use of electronic communication. The team will inventory the options for electronic communication available to the members of the committees and identify and recommend the most feasible one for implementation. This will include the use of the home page for the project, in which a variety of material will be posted for review and downloading by interested parties.

The training recommendations will be reviewed and approved by ODOT staff. The consultant team will then be responsible for providing the training as outlined in the training plan. This will include all accommodations, preparations, class materials, instructors, and video recording of instruction.

Product:

1. Draft narrative report with recommendations for University Research including draft work scopes, schedules, and suggested compensation rates.
2. Draft informal training plan including training identification, goals, objectives, schedules, and level of staffing commitment. The informal training will consist of the hands on training provided during the day to day work over the course of this contract such as the development and implementation of models.
3. Draft formal training plan including identification and type (class room, conference, etc.) of training, goals, objectives, schedule, audience, and possible class size. This will include any formal training that university staff may be able to provide during this contract.
4. 3 Final reports and documentation for (1) university research, (2) informal and (3) formal training incorporating editorial changes and pertinent comments from ODOT and other participating agencies
5. Provide training as depicted in the informal and formal training plans
6. Provide original instructors training materials for all training

Schedule: The recommendations for the university research will be completed by 30 May 1996, as it will be an important resource in the development of the recommendations prepared during Task 1.6. The ODOT review and revisions will be completed by 30 June 1996. The training plans will be completed by 30 June 1996. ODOT review, editorial changes and approval will be completed by 31 July 1996. Implementation of training will be completed by 30 June 1996.

Task 3.2: Prepare Recommendations for Resource and Staffing Requirements

Discussion: The purpose of this task is to assess the ways in which ODOT and local government agencies (primarily MPOs) currently perform the work related to travel models and model integration such as in Phase 2 of this contract. This will set the stage for recommendations on future resource and staffing requirements. In all agencies, implementation of forecasting models is constrained as much or more by limitations on staff resources as by limitations of data, models, or software. The planners ability to improve or refine the methods used in transportation and land use forecasts are also constrained by the demand for the applications of these tools. In this phase of the work, the consultant team will asses these constraints and make recommendations to ODOT and participating MPOs in both resources (financial and human) and cooperative arrangements to implement an integrated model program as developed in Phase 2. The review will focus on agencies Unified Planning Work Program. The consultant team's approach to the completion of this task consists of the following:

1. *Direct, close, cooperative discussions* with affected agencies, through the Modeling Steering Group and through direct outreach to key staff around the state. Estimates of future staffing requirements cannot be estimated without direct input from the participating agencies and units of government.
2. *An emphasis on the specific requirements of the integrated model systems.* Estimates of resources required for data collection and model maintenance must be grounded in the specifics of the models and must have a minimum of an irrelevant data collection.
3. *Review existing resources spent on forecasting.* It is not sufficient merely to develop recommendations for future staffing requirements. The gap between what may be necessary to support a higher level of modeling capacity and the current, resource constrained efforts of local governments may be substantial. Only by having a clear sense of current levels of effort will the team be able to make realistic recommendations for future levels of effort.
4. *Incremental development.* The guidelines for integrated models must recognize the need for capacity and staff to evolve over time. Just as was done by the PB team in the statewide Travel Demand Modeling Guidelines, there is a need to recognize that many of the involved jurisdictions will evolve slowly toward the highest standards identified in the guidelines for integrated modeling. At each stage of this evolution, distinct staffing and resource requirements must be met.
5. *The use of a prototype/model set of recommendations.* It may be necessary to focus attention on a small number of agencies whose capabilities will serve as prototypes for other agencies similar in size or location. In this way the PB team can focus their resources to make sure that the in-depth investigation and discussion necessary to develop these recommendations can be successful.
6. *Inter-agency cooperation.* In this resource constrained era or government, the cooperative maintenance and development of capabilities for integrated modeling is essential. The PB team will propose and evaluate the most efficient methods for implementing the models. This will likely involve expanding on the partnerships which are already beginning to form between state and local agencies.,
7. *Seeking funds from new sources.* Just as the development of models will be a pioneering effort, so must the identification and assembly of resources to implement the models. The PB team anticipates proposing innovative ways of using federal funds. The PB team anticipates open and cooperative conversations with federal agencies such as FHWA and FTA, and the pursuit of implementation funds.

Note: This task does not propose establishing a new source of funding for local agencies and MPOs from ODOT resources. Rather, it will outline the resources which will be required for both ODOT and other agencies to effectively use the model.

Product:

1. Draft technical report containing definitive recommendations for resources (financial and human) for ODOT and other Steering Committee participants (minimum MPOs and DAS Economic Analysis).
2. Draft report recommending improved and additional cooperative arrangements between agencies.
3. Final reports and documentation for recommendations on resources and cooperative arrangements incorporating editorial changes and pertinent comments from ODOT and other participating agencies

As noted, it should be understood that this work will not propose ODOT funding for outside agencies, but rather recommend timely and low-cost techniques for model integration.

Schedule: The work and product will be completed by I May 1997. The ODOT review and editorial changes will be completed by 30 June 1997.

Task 3.3: Implement a Prototype Study for a Land Use Allocation Model

Discussion: The purpose of this task is to calibrate, implement and test the land use allocation model developed in Phase 2 for a metropolitan region or super region such as the Willamette Valley in western Oregon. By this point in the project, it is assumed that the development of the prototype is complete and that the necessary data for its calibration and implementation has been assembled. These tasks are presumed to have been performed in Phase 2. Further, it is assumed that the location for the prototype application will have been determined by agreement among the technical consultants, ODOT staff, and the relevant committees. This would be based upon a review of project goals and objectives, as well as available data and an analysis of opportunities and constraints associated with alternative sites for prototype implementation. Therefore, the work to be performed in this task consists of the following:

1. The installation of the prototype model software at ODOT and participating agency(s)
2. The involvement of cognizant staff from the appropriate jurisdictions in the process of calibration and testing.
3. The identification and implementation of a scenario with relevance to the policy issues being faced in the affected jurisdiction.
4. The evaluation of this scenario in terms of its likely accuracy. The processes just described are similar to those performed by the Parsons Brinckerhoff team in the calibration and testing of EMME/2 in the Salem metropolitan area for the Mid-Willamette Valley. This process serves as a example of what the PB team foresees will occur for the integrated land use model as well. It will be substantially enhanced by the inclusion of the results of major national research project being conducted by the PB team, whose completion is anticipated in 1997, coincident with the completion of this phase of Oregon's Integrated Model Development Program. For the National Cooperative Highway Research Program, the PB team is completing a best practices manual on the tools and techniques available for evaluation of the land use impacts of transportation investments. This best practices manual will cover the complete spectrum of techniques used today, ranging from the most basic (interviewing and qualitative data analysis techniques) to the most sophisticated, of which Oregon's Integrated

Land Use Model will surely be a leading example. The team plans to draw heavily from this document in order to identify the levels of analysis that are suitable to the transportation projects in the varied context of the transportation development process in Oregon. Key issues in this task include the following:

5. *Training.* The PB team will make a commitment to the full and meaningful participation of ODOT and participating agency technical staff in the calibration and testing of the land use and GIS prototype models. This training will be in accordance with the training plans developed under Task 3.1
6. *Communication.* PB team is committed to a meaningful level of communication using multiple means and media, in order both to train appropriate staff and inform the wider audience of committees and other constituencies about the progress of the prototype implementation.
7. *Demonstration.* The successful completion of this task requires the demonstration of the ability of the prototype to perform as planned.

Lastly, the team envisions a final face-to-face meeting at which the prototype will be discussed, and any further outstanding issues relating to its implementation will be reviewed. The combination of electronic, face-to-face, and written communication will make possible the implementation of the training, communication and demonstration objectives of this task.

Products:

1. Draft technical report in the form of best practice users guides and procedure manuals detailing the design, implementation, demonstration, and calibration of the land use models and integration process. These documents will become the standard resource for use by agencies throughout the state during subsequent integrated model development processes. The documents will also identify the levels of analysis that are suitable to the transportation planning applications in the varied context of the transportation and land use requirements in Oregon.
2. First generation Integrated land use model and GIS environment for a “to be” specified location in western Oregon, and supporting databases with user and appropriate Metadata documentation
3. All source code and executable modules including user documentation of software and software applications developed
4. Final technical reports and documentation incorporating editorial changes and pertinent comments from ODOT and other participating agencies
5. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: This task and its products will be completed by 30 April 1997. The ODOT comments and editorial changes to the reports, guides and technical references will be completed by 30 June 1997.

Task 3.4: Develop Recommendations for an Implementation Plan

Discussion: The purpose of this task is to compile and synthesize the work done on the previous Phase 3 tasks. It formalizes the results of work described in the descriptions to each of these tasks, above. The implementation plan which is the subject of this task will be multi-jurisdictional. It will be the result of substantial discussion with ODOT, the Modeling Steering Group, other professional staff from those agencies, and members of the PB team, with input as appropriate from the Peer Review Panel.

A plan for implementation of the statewide program must consider relevant institutional aspects, such as computer hardware and software requirements, user training requirements, database management, model enhancement and customization opportunities, and the policy issues that are relevant at the level of the implementing organization. The potential for collaboration with other state and regional agencies in the continued development of the modeling suite must be examined as well; there would appear to be substantial opportunities for the various study participants to continue the evolution of the GIS platform and databases initiated during this project. We anticipate that the lessons learned from the prototype study will prove invaluable to gauging the importance of these and other important implementation issues.

The implementation plan will focus on the second biennial stage of the project. There may be a need to develop certain elements of the plan earlier than others, depending on the needs and budget schedule of each of the participating agencies and governments. The PB team will respond to these schedule constraints through the frequent user contacts maintained in this contract, as well as discussions with user groups conducted during this task.

The prototype development and implementation will be central to the development of the final implementation plan. Thorough review of the results of the prototype stage will be conducted by the project team, together with the Peer Review Panel, before commitments are made either to methods or budgets for the next phase of work.

Product:

1. Draft technical report describing the path to the full implementation of the statewide model integration program. It will include recommended research and development activities for further model development and integration with regional and metropolitan models. Recommendations for implementation will include a timetable and phasing plan.
2. Final technical reports and documentation incorporating editorial changes and pertinent comments from ODOT and other participating agencies
3. Final technical reports and applicable documentation posted on the ODOT home page

Schedule: This task will be completed by 30 May 1997, and ODOT review and editorial changes will be completed by 30 June 1997.