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16. Abstract

Many Departments of Transportation (DOTs), including the Texas Department of Transportation (TxDOT), have been challenged by inadequate funding from traditional federal and state fuel taxes, increasing construction costs, aging highway systems, traffic congestion, and recent natural disasters, compromising their primary mission to provide safe vehicle transportation routes with adequate capacity. Furthermore, environmental awareness and sustainability concepts have strengthened and sparked debates in Congress, culminating with several regulatory policies that affect transportation projects. This scenario has prompted DOTs to pursue innovative ways to reduce maintenance cost (at minimum), generate revenue (at maximum) by exploiting their assets, and meet the new regulations. Likewise, the Center of Transportation Research at The University of Texas at Austin undertook a comprehensive research study to identify and determine when, where, and under what circumstances TxDOT should pursue the implementation of Value Extraction Applications (VEA), and how to effectively recognize and involve key stakeholders. As a result, 11 VEAs were identified. In addition, a methodological framework—embedding a multi-attribute criteria analysis matrix as the decision making method—was devised to guide TxDOT through the process of identifying, evaluating, comparing, and selecting the most appropriate VEA. A list of stakeholders associated with each VEA and an analysis framework was provided to help TxDOT to identify and reach out to key stakeholders.

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Guidance on Extracting Value from TxDOT's Land Holdings

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Jolanda Prozzi
Research Supervisor

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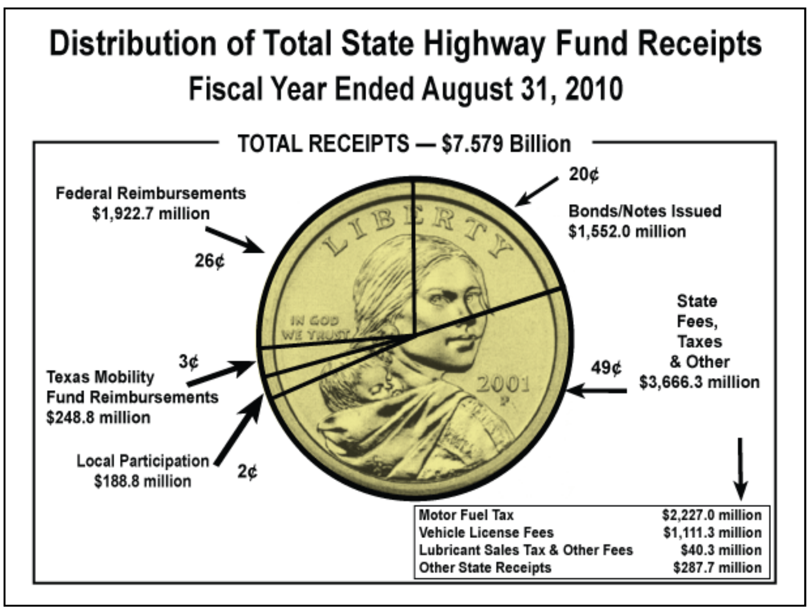
Chapter 1. Introduction

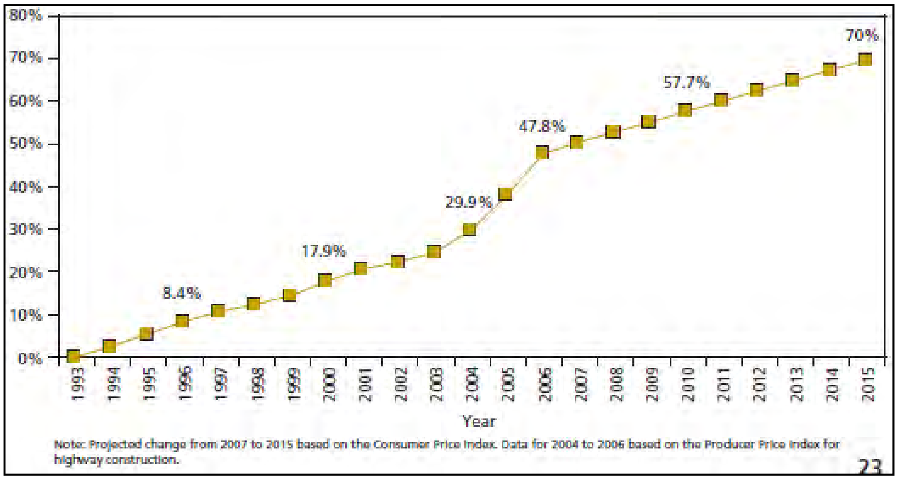
1.1 Background Motivation and Research Need

Many State Departments of Transportation (State DOTs), including the Texas Department of Transportation (TxDOT), are increasingly challenged by inadequate revenue from traditional federal and state fuel taxes. These fuel taxes—which comprise about 50% of the Texas highway fund receipts (see Figure 1.1)—were conceived in the 1950s as an indirect charge to recover the costs of vehicle travel on the U.S. highway system. Fuel taxes have, however, not increased with the inflation rate. Given increasing maintenance and construction costs (see Figure 1.2) and more fuel-efficient vehicles, the vehicle per mile tax has become largely inadequate. This inadequate funding from the traditional fuel tax, together with increased demand for transportation and the increasing maintenance needs of an aging highway system, have thus resulted in significant deficits. Further, State DOTs have also had to deal with rescissions implemented to fund unexpected expenditures, including the relief efforts and reconstruction after Hurricanes Katrina, Rita, and Ike.



Source: Susan Combs Texas Controller of Public Accounts (2010)

Figure 1.1: 2010 Total State Highway Fund Receipts



Source: AASHTO (2007)

Figure 1.2: Trends in Construction Costs

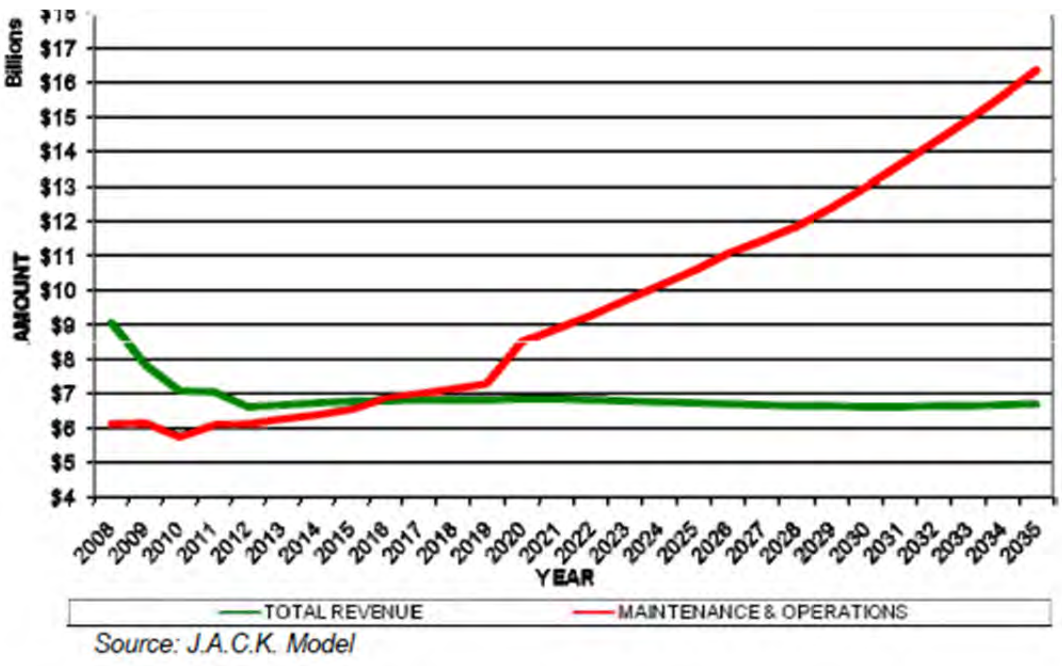
Recent analyses in Texas, including the 2030 Committee report, have consistently pointed to significant deficits and an increasing gap between available funding and increasing maintenance and capacity needs. The 2030 Committee recommended a minimum investment of $14.3 billion per year by TxDOT to attain the agency's goals (see Figure 1.3)—nearly double Texas's highway fund receipts (see Figure 1.1). Furthermore, the Joint Analysis Using Combined Knowledge (J.A.C.K.) model, a financial planning and forecasting tool developed by TxDOT, predicted that by 2016 no funds will be available for highway expansion (see Figure 1.4). Inadequate funding and increased funding needs have thus sparked interest in the extraction of additional value from TxDOT's right-of-way (ROW) and other land holdings.

TOTAL INVESTMENT NEEDED (2008 $)

	2009-2030	Per Year
Pavements	$ 89 Billion	$ 4.0 Billion
Bridges	$ 36 Billion	$ 1.6 Billion
Urban Mobility	$171 Billion*	$ 7.8 Billion*
Rural Mobility & Safety	$ 19 Billion	$ 0.9 Billion
TOTAL	**$315 Billion**	**$14.3 Billion**

Source: TxDOT 2030 Committee (2009)

Figure 1.3: Total Investment Needed by TxDOT until 2030



Source: Persad (2009)

Figure 1.4: TxDOT Total Revenue vs. Maintenance & Operation Costs

In August 2010, TxDOT funded the Center for Transportation Research (CTR) at The University of Texas at Austin to conduct a research study to (a) identify and determine when, where, and under what circumstances TxDOT should pursue the implementation of which value extraction applications (VEAs) and (b) provide the agency with structured guidance on identifying and involving key stakeholders in the implementation of feasible VEAs.

1.2 Research Objectives

The primary objective of this research study was to identify ways for TxDOT to extract value[1] from its highway ROW and assets (i.e., buildings, and other land holdings) without compromising the Department's primary mission to provide safe vehicle transportation routes with adequate capacity. The research subsequently

- compiled and synthetized consultancy reports, documented research, and other publicly available information regarding potential VEAs;
- examined the requirements, barriers, and challenges associated with implementing potential VEA in Texas;
- evaluated the impacts (i.e., positive or negative) associated with the implementation of each identified VE;
- developed a framework and assessment matrix to guide and assist TxDOT in identifying and implementing the most promising VEAs given the TxDOT asset and objective; and

[1]Value is here understood as (1) revenue streams, (2) cost savings, and (3) societal benefits, including environmental benefits, which are not necessarily quantifiable in monetary terms.

- developed a stakeholder analysis framework that provides guidance on identifying and involving key stakeholders in the implementation of feasible VEAs.

1.3 Research Scope and Limitation

This research analyzed and evaluated identified VEAs given TxDOT's objectives and certain ROW properties (see Figure 1.5).

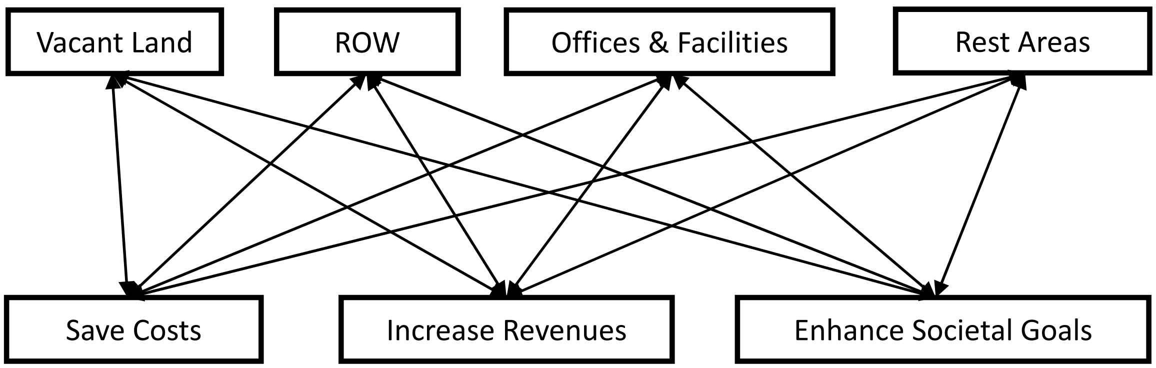


Figure 1.5: Interaction of TxDOT's Assets and Objectives

The research revealed 11 potential VEAs:

- Property Management;
- Airspace Leasing—Buildings;
- Airspace Leasing—Parking Lot;
- ROW Leasing—Utilities and Telecommunication;
- Advertising;
- Solar Panels;
- Wind Turbines;
- Geothermal Energy;
- Special Roads (Solar Road and Piezoelectric Energy);
- Carbon Sequestration and Biomass; and
- Wildlife Crossings.

Each identified VEA was evaluated using the following seven criteria:

- Technical Feasibility;
- Political/Public Concerns;
- Legal Considerations;
- Financial/Economic Feasibility;

- Environmental Considerations;
- Potential Social Impacts/Benefits; and
- Safety Considerations.

Note that the information and data considered and presented in this report reflect current available technologies, current costs, current political considerations, existing federal and state legislation, and existing TxDOT policies and regulations. Changes to any of these parameters may influence and modify the consideration and feasibility of the identified VEAs.

1.4 Report Structure

This report consists of six chapters. Following this Introduction, Chapter 2 presents the research methodology, including the literature review and an overview of the interviews conducted, as well as an introduction to multi-attribute criteria analysis and the evaluation matrix used to evaluate and compare VEAs. Chapter 3 provides a detailed review of each VEA in terms of the seven evaluation criteria, as well as identified best practices and concluding remarks. Chapter 4 presents the methodological framework and VEA evaluation matrix developed to assist TxDOT in identifying and implementing feasible VEAs. Chapter 5 describes the stakeholder analysis framework and public outreach plan. Finally, Chapter 6 offers final remarks.

This report also includes nine appendices:

- Appendix I contains a legal memorandum that discusses the main laws and regulations concerning the use and management of a public asset.
- Appendix II illustrates the inputs and outputs of the methodological framework developed.
- Appendix III presents the questionnaire used to characterize TxDOT's assets and filter potential VEAs.
- Appendix IV summarizes the advantages and disadvantages/requirements of each VEA.
- Appendix V presents the questions that are used to evaluate each VEA in terms of the seven criteria identified.
- Appendix VI provides examples and best practices pertaining to each VEA.
- Appendix VII lists potential stakeholders that should be involved when considering for each VEA.
- Appendix VIII summarizes the input that was obtained from TxDOT's Dallas, El Paso, Houston, Paris, Tyler, and Yoakum Districts on the information collected and the VEA framework developed by the research team.
- Appendix IX presents the PowerPoint slides of a presentation entitled "Potential Value Extraction from TxDOT's Right-of-Way and Other Property Assets."

Chapter 2. Research Methodology, Background Review, and Evaluation Matrix

This chapter compromises two sections: (1) an overview of the research methodology that briefly details the tasks undertaken and (2) an explanation of the multi-attribute criteria (MAC) analysis theory used to evaluate and compare potential VEAs.

2.1 Research Methodology

This research comprised seven major tasks:

1. Conduct literature and background review;
2. Identify best practice VEAs;
3. Assess legal issues and concerns;
4. Develop VEA methodological framework;
5. Develop stakeholder analysis framework;
6. Conduct public outreach and finalize VEA methodological framework; and
7. Document research.

Figure 2.1 depicts the research method while the ensuing sub-sections briefly describe each of the aforementioned tasks.

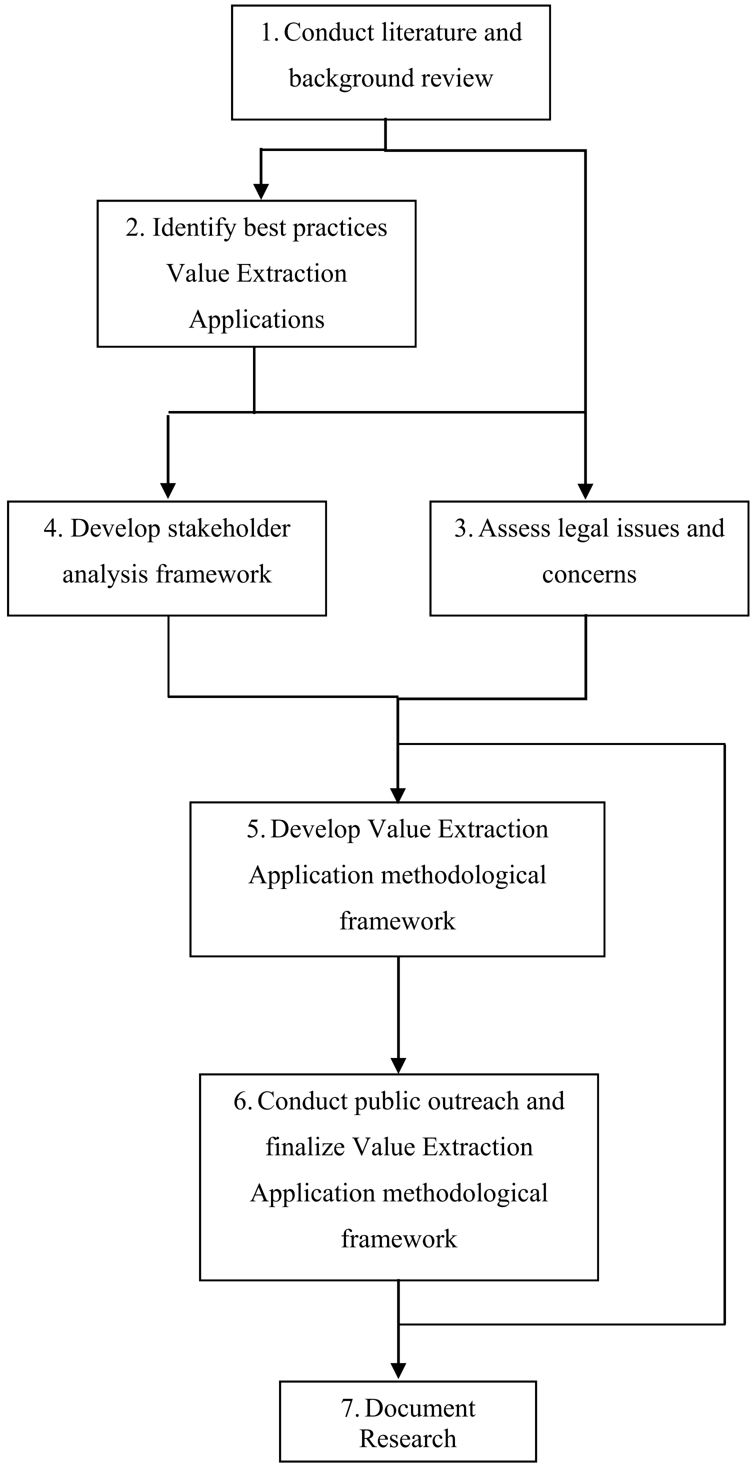


Figure 2.1: Flowchart of the research methodology

2.1.1 Conduct Literature and Background Review

The term VEA had to be clearly defined, understood, and agreed upon by TxDOT and the research team prior to initiating a literature review. Ultimately, VEA was defined as any activity that can be implemented on TxDOT properties (i.e., ROW, buildings, and land holdings) to (1) increase revenue streams, (2) save costs, or (3) provide societal benefits, including environmental benefits, which are not necessarily quantifiable in monetary terms. An extensive literature review was subsequently conducted. The literature review comprised a comprehensive and in-depth review of TxDOT studies and other published reports, articles, and documents to identify potential VEAs and to understand their respective challenges, barriers, benefits, and requirements.

During the literature review, the research team identified 11 VEAs.

- Property Management,
- Airspace Leasing—Buildings,
- Airspace Leasing—Parking Lot,
- ROW Leasing—Utilities and Telecommunication,
- Advertising,
- Solar Panels,
- Wind Turbines,
- Special Roads (Solar Road and Piezoelectric Energy),
- Geothermal Energy,
- Carbon Sequestration and Biomass, and
- Wildlife Crossing.

Although some research reports were also reviewed, most of the VEAs lacked comprehensive research and data. Wildlife crossings are perhaps the only VEA that have been the topic of extensive research with conclusive results regarding cost-effectiveness, benefits, and challenges. In the case of the renewable energy applications (i.e., solar panels, wind turbines, geothermal, and biomass and biofuel), various studies have assessed and analyzed the requirements, barriers, impacts, and cost-effectiveness of these types of projects. Most of the studies, however, did not consider the implementation of these applications on highway ROW and DOT properties. Thus, the conclusions were not always entirely applicable. On the other hand, some DOTs have been conducting pilot projects to evaluate the potential application of these renewable energy technologies in highway ROW. These pilot projects have provided important insights and information for this research project and were essential in developing the methodological framework (see Chapter 4). The literature review was also important in identifying leaders and experts on each VEA and for the development of questionnaires to guide the interviews.

The research team also reviewed relevant studies conducted for TxDOT to better understand the agency's needs, resources, expenses, and goals. Finally, a series of interviews was conducted with key TxDOT personnel and national leaders on different VEAs to supplement the literature findings.

2.1.2 Identify Best Practice Value Extraction Applications

The literature review helped identify and understand the factors that impact the feasibility of the different VEAs, such as geographic and spatial context, site characteristics, and legal constraints. The research team subsequently identified a number of best practices, which were defined as established projects or procedures, as well as case studies that demonstrate a successful implementation model. This allowed for the identification of "success" factors—i.e., factors that can increase the likelihood of successful implementation of a specific VEA—and necessary conditions, which would hinder or preclude the achievement of the intended objective (i.e., revenue generating cost savings and/or enhance societal benefits) if absent. The factors and necessary conditions were thus identified from the lessons learned by early adopters and the initial findings and conclusions of ongoing pilot projects.

2.1.3 Assess Legal Issues and Concerns

Legal issues and concerns are an important consideration when implementing any activity on a public asset. In the case of the transportation sector, state and federal legislation, the Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO) regulations, and internal DOT policies govern the types of activities that can and cannot occur on ROW and properties held or purchased by DOTs. The research team thus assessed the legal framework and legal constraints under which TxDOT can potentially extract additional value from its ROW and other land holdings. Chapter 3 highlights the major legal considerations regarding each VEA, while Appendix I provides a detailed review of the legal aspects associated with the use of transportation and public assets.

2.1.4 Develop Stakeholder Analysis Framework

In any public project, especially transportation projects, a diversified and large group of stakeholders[2] is typically involved. However, the level of interest and influence may vary among the different groups and largely depend on the type and location of the project. While failing to reach out to specific stakeholders can jeopardize a project's implementation and progress, an extensive outreach program to stakeholders that are not interested in or affected by the project can be very costly and inefficient for the DOT. Therefore, effectively identifying, reaching out to, and involving key stakeholders[3] not only can save cost and resources, but can also be crucial to ensure the successful implementation of a VEA. The research team thus developed a stakeholder analysis framework to assist TxDOT in identifying key stakeholders and selecting the most effective outreach technique to engage these stakeholders.

The stakeholder analysis framework is described in Chapter 5. Furthermore, a component of the stakeholder analysis framework—as an important component of the methodological framework developed in this research—is briefly presented in Chapter 4, while a list of stakeholders pertaining to each VEA is provided in Appendix VII.

2.1.5 Develop VEA Methodological Framework

The VEA methodological framework was developed based on information, findings, and outcomes of all the previous tasks. The VEA methodological framework is intended to assist and guide TxDOT in identifying the most feasible VEAs given the agency's objective and the characteristics of the asset. Chapter 4 presents the VEA methodological framework and explains

[2]Stakeholders: persons, groups, or institutions with interest in a project or policy or who may be directly or indirectly affected by the process or the outcome (World Health Organization, ND).
[3]Key Stakeholders: those who can significantly influence, or are important to the success of the project. (World Health Organization, ND)

each step in detail through a hypothetical case study. Appendix II provides the inputs and outputs for the steps of the methodological framework while Appendices III to IV provide the detailed information presented in Appendix II that are embedded within the methodological framework.

2.1.6 Conduct Public Outreach and Finalize Value Extraction Application Methodological Framework

After developing the preliminary version of the VEA methodological framework, the research team conducted outreach to six TxDOT districts to (a) demonstrate the framework and evaluation matrix to key potential TxDOT users for review and comment and (b) finalize the VEA methodological framework considering the inputs from the potential users. This step was fundamental to ensure the applicability, effectiveness, and understanding of the developed VEA framework. Meetings were held with TxDOT district personnel from different divisions such as Transportation Planning and Programming (TP&P), maintenance, environmental, public information, and safety. The six districts comprised Dallas, El Paso, Houston, Paris, Tyler, and Yoakum. Appendix VIII lists the input obtained by District and the follow-up research conducted by the research team regarding some of the pointes raised.

2.2 Interviews

Specifically, the research team obtained insights and current results that have not been published, as well as a better understanding of the implementation process and main obstacles encountered and addressed. All interviews with TxDOT were conducted face-to-face, while telephone interviews were conducted with other DOT representatives.

2.3 Multi-Attribute Criteria Analysis and Evaluation Matrix

A further decision analysis framework was required to assist TxDOT in evaluating and comparing potential VEAs and identifying the most appropriate VEA given the asset type and the agency's objective. This section introduces the concept of multi-attribute criteria (MAC) analysis, which was used to compare the different VEAs. Each criterion embedded in the decision analysis framework is defined and the evaluation matrix developed to assess and compare potential VEAs is presented.

2.3.1 Multi-Attribute Criteria Analysis

Multi-attribute criteria (MAC) analysis is a decision-making technique commonly used to assess solutions that involve trade-offs (e.g., cost and schedule) or compare alternatives. Typically, the decision making involves several attributes or impacts that pertain to potential alternatives. This attributes usually have different scales (i.e., units of measurement) or are merely qualitative (i.e., cannot be quantified) and can therefore not be directly compared or combined into a unique measure (e.g., monetary). Furthermore, the level of importance of each attribute may differ given the goal of the decision maker. In the case of VEAs, seven criteria were identified to represent the universe of attributes and impacts that should be considered when implementing a VEA:

- Technical Feasibility;
- Political/Public Concerns;

- Legal Considerations;
- Financial/Economic Feasibility;
- Environmental Considerations;
- Potential Social Impacts/Benefits; and
- Safety Considerations.

By analyzing and evaluating potential VEAs according to these seven criteria, TxDOT can consider and apply the information gathered from the best practices to the Texas case at hand, thereby considering the actual features and challenges of the project location. Furthermore, all the potential VEAs can be assessed given the same criteria, thereby enabling direct comparison.

2.3.2 Criteria Definition

To evaluate and compare potential VEAs, it is essential to have a clear understanding of the meaning of each criterion used in the evaluation. This section provides a description and examples for each criterion included in the MAC analysis.

2.3.2.1 Technical Feasibility

Technical Feasibility refers to the technical requirements for the successful implementation of a VEA. For example, a site's characteristics are a major factor for several VEAs such as solar panels (e.g., proximity to transmission lines, slope of terrain, and minimum of five acres of available land) and biomass (e.g., minimum 15 inches of rainfall, soil characteristics, distance to biorefineries, and minimum of one acre of available land). Technical feasibility also concerns engineering and construction standards and requirements. For example, to construct a building over a highway the distance between columns (i.e., free span), minimal clearance, construction methods, and access to the jobsite can impose challenges that can prevent project execution.

2.3.2.2 Political/Public Concerns

The political and public concerns criterion refers to how the VEA will likely be perceived by the general public and politicians. In other words, the political and public concerns criterion assesses whether the VEA is controversial, the potential impacts on nearby communities and businesses, the likelihood of public opposition, and the potential impacts on TxDOT's image. For example, the selling or leasing of vacant land for a new business development can negatively impact neighboring communities (e.g., increase traffic congestion and decrease property values) and existing businesses (e.g., concurrence), thereby causing public dissatisfaction. Some VEAs can, on the other hand, enhance TxDOT's image and receive support from nearby communities, as well as local politicians. These positive perceptions will likely occur if the VEA enhances public goodwill and/or social benefits without increasing tax payments. For example, wildlife crossings can integrate habitats, protect endangered species, enhance road safety, create jobs, and, even reduce car insurance premiums. Another example is parking lots under highways that can alleviate traffic congestion, stimulate business development, and secure revenue for TxDOT.

2.3.2.3 Legal Considerations

Legal considerations include federal and state legislation, FHWA policies and regulations, the National Environmental Policy Act (NEPA) and other environmental regulations, Federal Aviation Association (FAA) regulations, and AASHTO policies, which can directly or indirectly affect and/or drive the implementation of a potential VEA. Legal considerations also include studies and analysis that must be conducted, as well as permits and licenses that must be obtained. Finally, legal considerations pertain to written agreements, liabilities, business models, and responsibilities. For example, federal and state regulations govern the types of activities that can and cannot occur on ROW held by DOTs or purchased by the DOTs. 23 Code of Federal Regulations (CFR) Chapter 1, for the most part, regulates the activities and opportunities that DOTs are granted vis-à-vis the federal system of interstate highways. Moreover, federal law currently prohibits DOTs from privatizing and commercializing rest areas along interstate highways. In Texas, the Texas Transportation Code and Texas Administrative Code govern the activities and opportunities surrounding TxDOT's ROW and real estate assets. Furthermore, Transportation Code Sub-chapter C of Chapter 202 governs leases, easements, and agreements that concern highway property. Section 202.052 *allows the department to lease a highway asset, part of the ROW, or airspace above or underground a highway, if the department determines that the interest to be leased will not be needed for a highway purpose during the term of the lease*. Also in Texas, *"TxDOT regulates the display of off-premise outdoor advertising signs along highways regulated by the Highway Beautification Act (HBA) and all other highways and roads located outside of the corporate limits of cities, towns and villages in Texas under the State Rural Roads Act (RRA)."* In some cases, a lack of zoning law can defer or even impair the implementation of VEAs such as solar, wind, and geothermal projects. Also, environmental analysis is a requirement for any project on public land. A solar project, for example, must comply with NEPA—either the FHWA or the DOE process, if not both—to receive an environmental permit. Finally, any construction exceeding 200 ft requires completing the form "74601-Notice of Proposed Construction or Alteration" with the Federal Aviation Administration (FAA) prior to its outset. The FAA and the Department of Defense (DOD) will review the form and issue a permit.

2.3.2.4 Financial/Economic Feasibility

The implementation of any VEA requires an upfront investment by TxDOT and/or private investors. The financial/economic feasibility criterion evaluates the upfront investment and the consequential payback period, as well as the potential financial and economic benefits that the implementation of a VEA can bring to TxDOT and society. For example, wildlife crossings typically require an investment of $1 to $3 million by the DOT, but the investment can be recovered through cost savings from eliminating the need to remove animal carcasses and vehicle wrecks caused by animal-vehicle-crash incidents (AVC). Wildlife crossings also benefit society economically by reducing human fatalities and injuries from AVC accidents, reducing vehicle insurance premiums, and creating temporary jobs (i.e., construction jobs). Another example is the property management VEA, which can generate revenue for TxDOT (e.g., selling or leasing land lots or properties) and/or save costs (e.g., swap transaction that result in the DOT acquiring a new facility). Furthermore, property management applications that result in TxDOT selling land in prime real estate locations can stimulate economic development (i.e., creation of business opportunities and jobs in urban areas) and raise tax revenues for the state (i.e., payment of property taxes by private owners).

2.3.2.5 Environmental Considerations

Highway construction and use have been criticized for the associated environmental impacts, including habitat fragmentation, deforestation, noise and dust during and after construction, vehicle emissions (e.g., NOx, SOx CO, and CO_2), and threats to endangered species (e.g., animal-vehicle-crashes). The environmental considerations criterion assesses a VEA's potential impact on the environment. Wind turbines, for example, are a renewable and non-polluting energy source. Wind turbines can thus contribute to reduced greenhouse gases (GHG) emissions from power generation and help to combat global warming. On the other hand, wind turbines can be detrimental to nearby communities because of noise and shade, and also impact bird and bat populations.

2.3.2.6 Potential Social Impacts/Benefits

The social impacts and/or benefits criterion assesses a potential VEA's impact on business opportunities, economic development, job creation, and general societal welfare. For example, implementing a telecommunication tower in rural areas can enhance internet and cell-phone signals. This type of infrastructure can be essential for economic development in these areas. Moreover, the internet plays an important role in education and professional development.

In another example, privatizing rest areas may result in competition with local businesses in small communities, hence negatively impacting social welfare. On the other hand, well-served and interactive rest areas and welcome centers can potentially enhance tourism and create jobs in rural areas. Renewable energy projects (i.e., solar, wind, geothermal, and biomass energy) can be scaled (i.e., can be implemented with different sizes and capacities) and implemented close to end-users. This approach can reduce the cost of transmission lines and supply electricity to remote and rural areas, thereby promoting economic development, jobs, and societal welfare. On the other hand, renewable energy systems can impact nearby communities negatively (e.g., noise, shade, and property value reduction).

2.3.2.7 Safety Considerations

TxDOT's primary mission is to provide safe vehicle transportation routes with adequate capacity. The safety considerations criterion considers the potential impact of a VEA on the safety of road users and the general public. This criterion thus considers the adequacy of clear zones[4], obstacles and obstructions created, access needs, risks imposed during implementation or maintenance of the VEA, and the likelihood of increasing accidents. Rest areas, for example, are important for road safety. Privatizing and/or offering enhanced services at rest areas can motivate drivers to stop, avoid rest area closures, and, even, increase the availability of rest stops. Consequently, road accidents caused by "drowsy driving"—a serious problem that leads to thousands of automobile crashes each year—can be reduced and road safety can be enhanced. Another example is wildlife crossings. Several studies have demonstrated that a well-designed wildlife crossing can effectively enhance road safety and reduce the occurrence of AVC

[4]"The clear zone (also called the clear recovery area) is an area provided along highways to allow vehicles veering off the travel lane opportunity for safe recovery or stopping. The clear zone width (always measured from the edge of the travel lane) depends on several roadway factors, including: whether the surrounding area is rural or urban, the functional classification of the highway, the design speed, and average daily traffic (ADT)" (TxDOT glossary). For example, freeways shall have a minimum 30ft clear zone (Table 2-11: Horizontal Clearances, TxDOT design manual).

incidents. On the other hand, safety concerns may arise whenever a wildlife crossing is considered for an existing road. Safety is also a major concern when using advertising in highway ROW. The FHWA and the AAA Foundation for Traffic Safety argue that advertising can distract drivers, thereby causing accidents. Furthermore, signs and billboards must be located outside the clear zone to protect drivers that run off the road.

2.3.3 Evaluation Matrix

An evaluation matrix was conceptualized and designed by this research effort to guide TxDOT in the assessment and comparison of VEAs in determining the most appropriate VEA to be implemented in a specific context (i.e., asset, objective, and location). The evaluation matrix embeds MAC analysis as the decision making technique to compare potential VEAs in terms of feasibility and impact scores. Figure 2.2 presents the steps undertaken to develop the evaluation matrix, as well as the criteria, calculations, and outcomes pertaining to the VEA evaluation process. Table 2.1 provides the composition of the feasibility and impact scores.

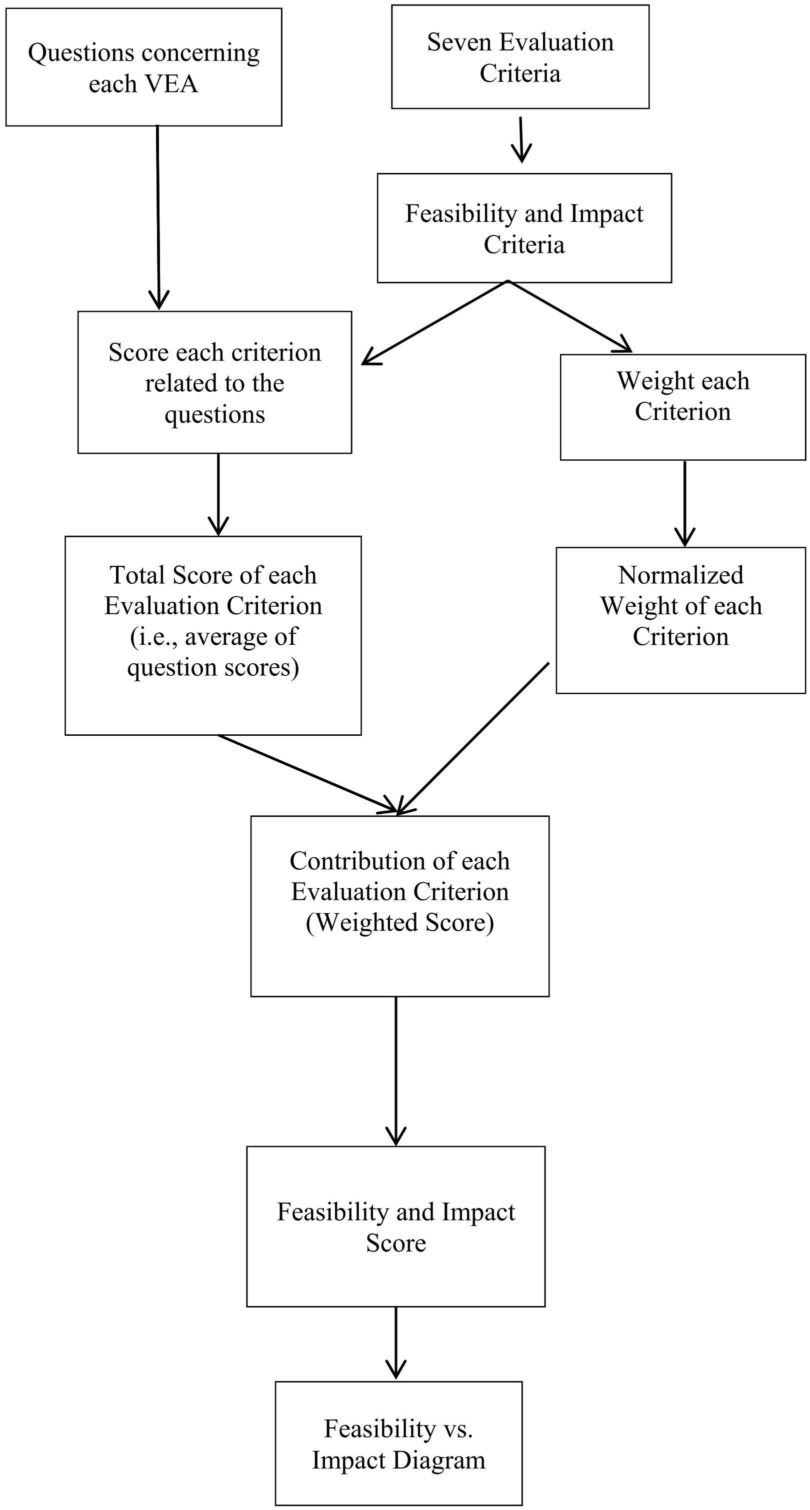
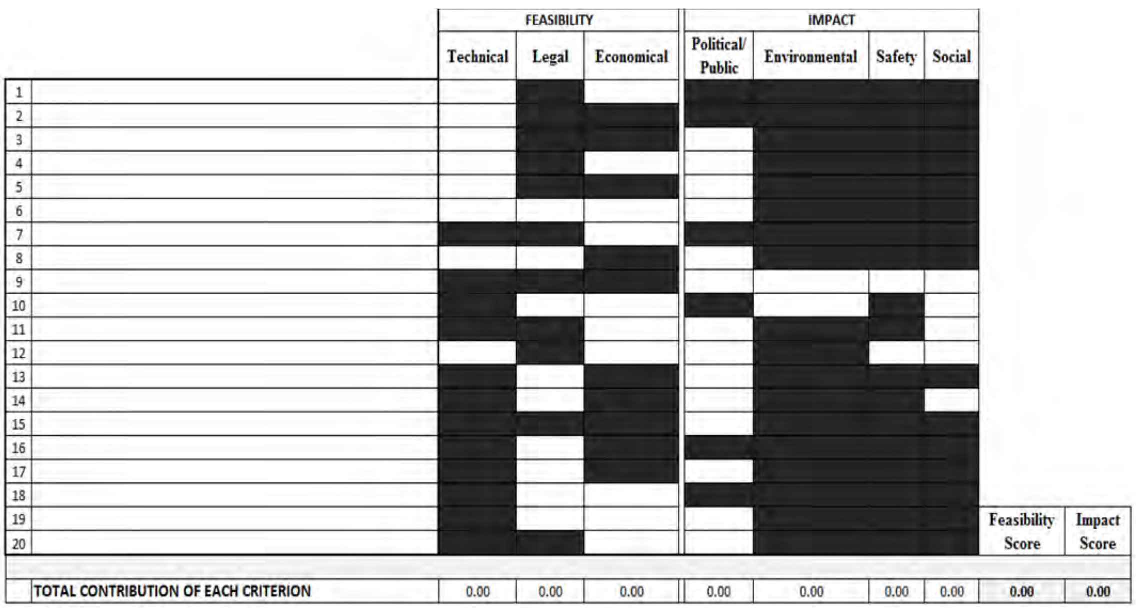


Figure 2.2: Flowchart of Multi-attribute and Evaluation Matrix Analysis

Table 2.1: Composition of Feasibility and Impact Scores

Feasibility Score	Impact Score
Technical Feasibility	Political/Public Concerns
Legal Considerations	Environmental Considerations
Financial/Economic Feasibility	Potential Social Impacts/Benefits
	Safety Considerations

The evaluation matrix includes a series of questions that were developed based on information gathered during the literature review. The questions address one or more of the identified criteria and are intended to help TxDOT consider the various factors that can influence the implementation of each potential VEA. Figure 2.3 shows the evaluation matrix template.



		FEASIBILITY			IMPACT					
		Technical	Legal	Economical	Political/ Public	Environmental	Safety	Social	Feasibility Score	Impact Score
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
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16										
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18										
19										
20										
	TOTAL CONTRIBUTION OF EACH CRITERION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 2.3: Evaluation Matrix Template

The user is required to evaluate each potential VEA separately, scoring each criterion (i.e., question) on a scale from -2 to 2 (see Table 2.2). The scores are used to convert a qualitative attribute into a quantitative measurement, thereby allowing direct comparison. The total score of each criterion (S) (i.e., Technical, Legal, Economic, Political/Public, Environmental, Safety and Social) is the average of the scores given to each question associated with a criterion (see formula below). Therefore, a positive criterion score does not necessarily imply a lack of concerns or negative impacts.

$$Criterion\ Score\ (Sj) = \frac{\sum_{i=1}^{i=n} Question\ Score\ (si)}{n}$$

Where,

n is the number of questions related to the criterion.

Table 2.2: Criteria Score Scale

Score Scale		
Negative Impact	-2	Major Concerns or Barriers
	-1.5	
Somewhat Negative Impact	-1.0	Minor Concerns or Barriers
	-0.5	
Neutral	0	Neutral
	0.5	
Somewhat Positive Impact	1.0	Minor Benefits
	1.5	
Positive Impact	2.0	Major Benefits

As previously mentioned, each criterion may also have a different level of significance (i.e., weight) in the decision process depending on the intended objective, project location, and type of asset. To reflect and incorporate the importance of each criterion in the decision analysis, the user can use criteria weights. Different methods can be used to assign criteria weights. For example, a maximum score (e.g., 1, 10, or 100) can be assigned to the criterion with the highest importance and the other criteria can then be assessed relative to the most important criterion. Alternatively, a total weight can be distributed among the criteria relative to the importance as a feasibility or impact criterion. Regardless of the approach or scale adopted to weigh the criteria, the weights (w_i) will be normalized. The normalized weight (W_i) is determined by dividing the criterion weight (wi) by the sum of the criteria weights that comprise the feasibility or impact score (see the following formula).

$$Wi = \frac{wi}{\sum_{i=1}^{i=n} wi}$$

Where,

w_i or w_j is the weight scale of a criterion (e.g., technical, environmental, and safety);

n is the number of criteria pertaining to the feasibility or impact score.

For example, in Table 2.3 a scale of 1 to 10 was used to weigh the criteria. The normalized weight of the economic criterion (i.e., 0.32) was calculated by dividing 7 (i.e., economic criterion weight) by 22 (i.e., sum of the weights of technical [5[, legal [10], and Economic [7] criteria). Note that the sum of the normalized weights for the feasibility and impact criteria must equal 1 (e.g., 0.23+0.45+0.32=1), respectively.

Table 2.3: Example of Weight Scale and Normalized Weight

		Normalized Weight	Weight Scale
Feasibility	Technical	0.23	5
	Legal	0.45	10
	Economic	0.32	7
Impact	Political/Public	0.21	6
	Environmental	0.24	7
	Safety	0.34	10
	Social	0.21	6

Finally, the feasibility (fs) and impact (Is) scores of each potential VEA are calculated by adding the product of the normalized criterion weights and the total criterion scores (see formula below). The fs and Is scores are subsequently plotted (see Figure 2.4). The fs and Is scores are the VEA X-axis and Y-axis coordinates, respectively. The chart is divided in four quadrants to help the user identify the VEA with the most potential (i.e., inside the green quadrant and closer to the upper right corner) (see Figure 2.4). Chapter 4 provides an example of how the evaluation matrix, the scores, the weights, and the chart can be used in identifying the most appropriate VEA(s) for implementation.

$$fs \ or \ Is = \sum_{i=1}^{i=n} Wi \ x \ Si$$

Where,

W_i is the normalized weight of criterion i;

S_i is the total score of criterion i.

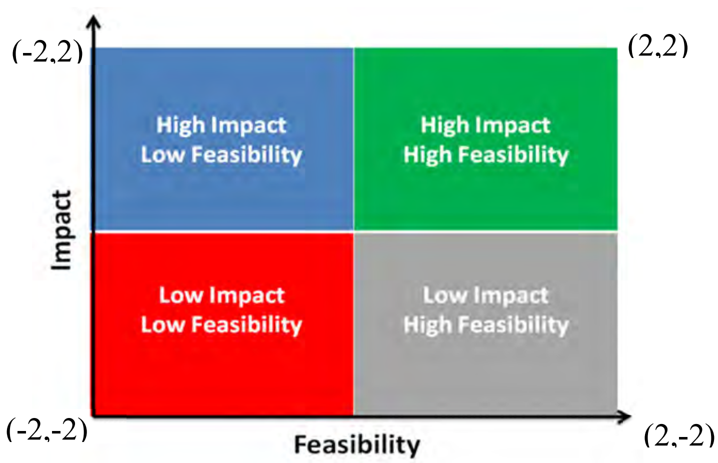


Figure 2.4: Example of Impact vs. Feasibility Diagram

2.4 Concluding Remarks

This chapter provided an overview of the research approach and the MAC framework used to evaluate and compare VEAs. MAC analysis is effective in evaluating alternatives that involve trade-offs (e.g., cost and schedule) and that are seemingly not comparable. The MAC analysis framework used in the evaluation of potential VEAs incorporates seven criteria (i.e., technical, legal, economic, political/public, environment, safety, and social) representing the universe of attributes and impacts that should be considered when implementing a VEA. Different levels of significance (i.e., weight) may, however, be assigned to the criteria in the decision process, depending on the intended objective (i.e., increase revenue, save cost, or enhance societal goals), project location, and type of asset. Potential VEAs are ultimately compared in terms of feasibility and impacts scores.

Chapter 3. Value Extraction Applications

This chapter contains a summary of the information and findings acquired during the review on of the literature and interviews conducted on each of the identified VEAs. Each sub-section introduces and discusses in detail one of the 11 identified VEAs in terms of the seven criteria adopted by the research team. Examples and best practices are also provided before the chapter concludes with some brief remarks.

3.1 Property Management

Some DOTs operate as a real estate agency selling, bartering, or leasing their property (i.e., land lots and buildings). These DOTs typically have internal departments that manage the properties and use the web primarily to disseminate information about potential real estate opportunities.

The property management application differs according to property type—i.e., rest areas, land lots, and buildings (offices, warehouses, storage yards)—and are therefore discussed separately in this section.

3.1.1 Property Management of Excess Land

Land lots are valuable assets to the DOTs and need to be carefully managed as the majority of the land owned by a DOT is for future use, including road expansion. However, these land lots also represent a considerable investment if unused. For example, in 1999, TxDOT-owned land amounted to an investment of nearly $161 million (see Table 3.1). These land holdings need to be maintained and managed, entailing expenditures, and investments by the DOT.

Buildings are also strategic business assets and essential for a DOT to perform its role and promote public service. Buildings are typically used to house a DOT's personnel, but in some occasions they can be leased and thereby generate revenue. Moreover, instances exist where DOT buildings in highly desirable locations can be swapped with a property in a less desirable location or even sold to the private sector.

Table 3.1: GLO Recommendations and TxDOT Action

Source: General Land Office, Real Property Evaluation Reports, TxDOT

Comparison of GLO recommendations and TxDOT action, 1996 to 1999

	1996		1999	
	# of Sites	Value of Land*	# of Sites	Value of Land*
Total number of sites owned by TxDOT	382	$201,910,000	432	$160,341,000
GLO Recommendations				
Sites recommended to retain	339	$63,284,000	385	$72,414,000
Sites recommended to sell or lease	43	$138,626,000	47	$87,927,000
TxDOT Action				
Sites sold or transferred	9	$652,536	15	$2,646,000
Partial sites sold or transferred	2	$127,900,000**		
Sites reclassified	5	$970,250	12	$26,333,000
Sites where no action was taken	32	$9,091,000	20	$58,948,000

*"This number is the GLO estimate of the value of land only. It does not include the value of facilities or represent the sale price" (TxDOT, 2001).

** "GLO estimated the total value of the land was $127,900,000. Part of the Leander site was sold for more than $18 million and part of the Sugarland site was transferred to other entities" (TxDOT, 2001).

3.1.1.1 Technical Feasibility

This VEA does not present any substantial technical challenges. A well-designed and updated website is potentially a valuable technical tool to facilitate a property management program, but it is not mandatory. An effective approach program is, however, essential to disseminate information about available properties and to engage interested entities. A representative of the California Department of Transportation (Caltrans) explained that Caltrans employs tools such as email, local newspapers, Craigslist, and its website to disseminate information and to reach out to likely buyers or lessees. Caltrans had also used E-bay, but encountered some legislative issues. Craigslist and email lists have proven to be very effective for selling properties in California. Also properties with a value of less than $1,000 can be sold without a bidding process.

Two major concerns when selling DOT properties are the evaluation of future highway network needs and the fair appraisal of the property. The intended use of the property and the impacts on nearby businesses, communities, and traffic also need to be assessed.

TxDOT's ability to manage its property assets has been questioned and it has been recommended that a strategic master plan with an annual review process be developed by the agency (Susan Combs, 2001). The General Land Office (GLO) evaluated in 1996 and reviewed in 1999 TxDOT's land assets and needs and recommended several land sales, leases, and barters (see Table 3.1). The GLO also highlighted several issues concerning TxDOT's process for evaluating property for retention or surplus. One of the issues was that the evaluation process occurred infrequently. TxDOT did not have a mandate or the staff resources to evaluate the agency's property use annually. A holistic review of TxDOT's land happens only when the GLO performs its evaluation of TxDOT's properties every 4 years (Susan Combs, 2001). For TxDOT to conduct its own property evaluation to facilitate timely and coherent property management decisions, it requires in-house staff with

> knowledge of best practices in efficient, least-cost space utilization and functional adjacencies, real estate market interaction for acquisition/disposition pricing, financial feasibility determinations, transaction structuring (where values and complexities warrant), strategic plan preparation that is proactive and anticipatory of future needs, and financial optimization (Susan Combs, 2001).

The ROW agents (i.e., the personnel who are responsible for assessing, negotiating, selling, leasing, and acquiring land, ROW, and properties) in Caltrans have backgrounds in business administration, construction management, economics, and real estate. Caltrans discourages the hiring of engineers for these positions. Furthermore, the ROW agents undergo academy training administered by the International ROW Association (IRWA). Caltrans pays for two training courses per year (Personal Communication with Caltrans, 2010).

3.1.1.2 Political/Public Concerns

Transparency is critical in the implementation of this VEA. TxDOT has to be careful when announcing and negotiating the lease, sale, or bartering of its properties. Therefore, auctions are recommended to ensure equal opportunities and transparency, as well as to set a fair market value for the asset. Moreover, the property or land's ultimate use may cause some concern for the public (neighbors), for example when a new business will be opened, a tall building be constructed, or an industrial facility be developed.

3.1.1.3 Legal Considerations

Both federal and state laws govern the disposal or lease of a TxDOT real estate property interest that is deemed to be in excess of the transportation needs.

At the federal level, for property acquired with federal funds, 23 CFR §710.409 deals with the disposal of real property interests that is deemed in excess to transportation needs. Under §710.409 (a) real property can be sold or conveyed to a public entity or a private party. Sub-section (b) requires that federal, state, and local agencies shall be given an opportunity to acquire property if it has a potential use for parks, conservation, recreational or other related purposes, and if state law allows such transfers. The State DOT is required to notify the appropriate resource agencies regarding the disposal intention. Placing the notice in the state's regular disposal notification listing fulfills that requirement. The DOT is, however, allowed to retain excess property to restore, preserve, or improve the scenic beauty and environmental quality adjacent to the transportation facility. If a property is transferred at less than fair market value for a public purpose interest approved and determined by the FHWA, the deed must provide for the property to revert back to the DOT given failure to continue public ownership and use. If the property is sold at a fair market value no reversion clause is required.

At the state level, Texas's Transportation Code (TC) governs the control (sale or lease) of real property assets. TC Chapter 202 lays out the control of transportation assets and under §202.021's provisions real property that is no longer needed—including ROW—can be transferred or sold if it was acquired for a highway purpose and it is determined that it is no longer needed for a state highway. The real property can be transferred or sold to a governmental entity with condemnation powers or to the general public (TC §202.021(b)). Highway ROW shall be transferred or sold given the following priorities: to a governmental entity with condemnation authority, to abutting or adjoining landowners, or to the general public.

§202.024 provides for the exchange of real property that is not needed for highway purposes, as a whole or as a partial consideration for another interest in real property needed for a state highway purpose.

Under TC §202.058 the department may also allow the owner of real property abutting or adjoining property acquired by the department for the ROW of a road in the state highway system, to use or cultivate a portion of the ROW not required for immediate use by the department. The agreement (in writing) may provide for

1. use or cultivation of the property;
2. construction of improvements on the property;
3. placement of fences on the property; and
4. other matters.

The department may not execute an agreement that would impair or relinquish the state's right to use the property for ROW when needed to construct or reconstruct the road for which it was acquired (§202.058 (d)). The use by the owner of adjoining or abutting property does not constitute abandonment of the property by the department.

TC §201.1055 governs the exchange of department-owned real property. Under §201.1055 (c) the Transportation Commission may authorize the director to exchange department-owned real property under Sub-section (a)(2) §201.1055 (d) requires that the Commission shall notify the Bond Review Board and Texas Public Finance Authority of the proposed transaction not less than 45 days before the date the Commission signs an agreement under this section providing for the exchange of department-owned real property under Sub-section (a)(2). The agreement for the exchange of department-owned real property under Sub-section (a)(2) that has an appraised value greater than the appraised value of real property and improvements acquired by the department under the agreement, must require the private entity to compensate the department for the difference.

Finally, property that has been acquired through eminent domain must comply with the new provisions enacted as a consequence of SB 18 of the 82nd Legislature.[5] Specifically, the right of repurchase set out in the amendment of Property Code 21.101 must be complied with if a property is not used for public use within 10 years of the taking. TxDOT will need to ensure that any excess property that has been acquired through eminent domain and has not been put to a public use (under a series of criteria set out in the new bill) by the 10th anniversary of the date of

5 For example, consider a scenario where property was taken by eminent domain for a new highway route and the remainder property not utilized for the highway is now owned by TxDOT. This remainder property could be subject to this new requirement.

acquisition has been offered in good faith to the previous owner for right of repurchase and that this offer has been extinguished as the agency has not received notice that the previous owner wants to purchase the real property.

Involvement of TxDOT's General Counsel (and on occasion the Attorney General) is recommended to review any contracts with private parties to minimize any potential risks and undesired liability to the DOT.

3.1.1.4 Financial/Economic Feasibility

The implementation of an effective property management system requires an initial investment in information systems (e.g., website, GIS database, etc.) and resources (i.e., management personnel). However, this VEA can potentially reduce maintenance costs and even generate revenue. Selling off land assets that do not have a current or future use helps a DOT to reduce its maintenance cost and allows a city and county to potentially levy taxes on the property. According to a GLO study, TxDOT had nearly $88 million (in 1999 dollars) in invested sites (lands) that could be sold or leased (see Table 3.1). This amount represents only the value of the land itself. The costs of relocating and replacing the district office, warehouse, and maintenance facilities, however, need to be factored in by TxDOT when making property management decisions.

3.1.1.5 Environmental Considerations

When conducting bartering transactions or land leases, or when selling properties, TxDOT should consider how the future owner or lessee will use the land asset to avoid environmental contamination or any polluting activity. Furthermore, federal and state legislation prohibit the lease or sale of public land for certain types of uses. Besides, the new use must comply with the NEPA and other relevant environmental regulations.

TC §202.061 allows the Commission to enter into an environmental covenant for the purpose of subjecting real property (which it has an ownership interest in) for environmental remediation if approved by the Texas Commission on Environmental Quality or a federal agency with such authority.

3.1.1.6 Potential Social Impacts/Benefits

Agreements or barter transactions involving public land and building assets with private entities will likely result in new business opportunities and consequently new jobs. Also, moving TxDOT's offices or warehouses from more valuable land areas—usually close to urban centers—to more distant sites can potentially aid in the development of the nearby communities at the new site. TxDOT can also pursue agreements with cities to allow the cities to use TxDOT's vacant land lots for temporary public parks or other community attractions in exchange for maintaining the land.

3.1.1.7. Safety Considerations

It has been argued that the maintenance cost of rest areas and non-used and under-used properties reduce the budget available for other priority services that affect the road condition and, ultimately, road safety.

3.1.1.8 Examples

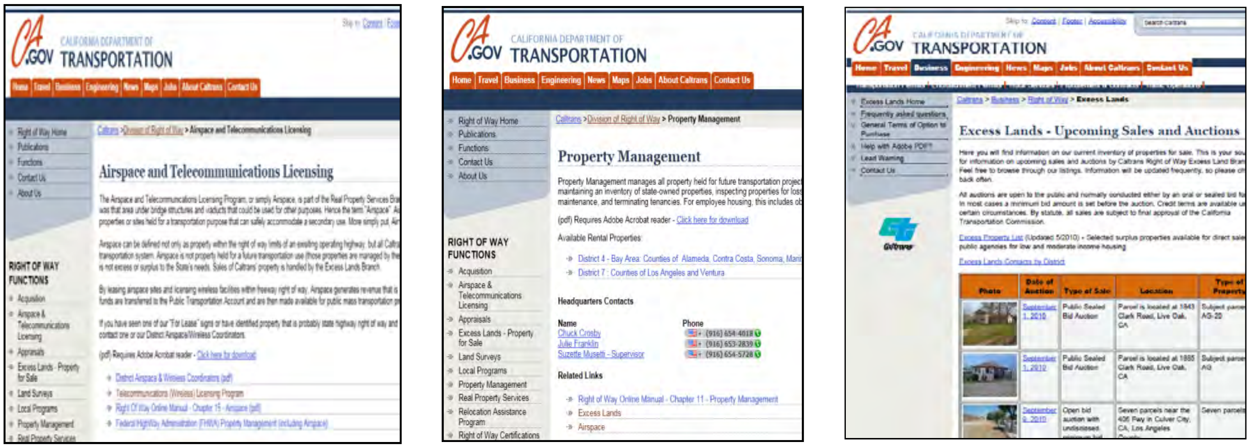
In terms of property management applications, a number of states have well-developed websites to announce auctions, post available assets, publish guidelines and requirements, and manage the interface between the DOT and the public. The Iowa DOT presents an example of how to generate revenue from property management. The Iowa DOT leases, sells, and swaps properties for purposes such as agriculture, residential housing, commercial buildings, and parking lots. The Iowa DOT uses a website (see Figure 3.1) as the primary means of communication between the agency and the public. The website provides access to manuals, guidelines, forms, and all documents related to an agreement (e.g., lease, sale, and swap), the property type (land, building, ROW), and permissable utilization.

Source: Iowa DOT (May 2010)

Figure 3.1: Iowa DOT’s Property Management Website

The best example in terms of the property management application, however, is the Caltrans program. Caltrans’s property management website contains detailed information regarding auction procedures, leasing guidelines, and property announcements. It is easy to navigate and is constantly updated (see Figure 3.2). In an interview with Caltrans Real Property Services Division, employees explained that the property management program is divided into three value extraction functions: airspace and ROW leasing[6], property management, and excess land sales (see Figure 3.2).

6 Caltrans’s airspace and ROW leasing program was created in 1961 as a trial when the FHWA gave Caltrans airspace leasing permission. This program is responsible for managing the airspace rights of Caltrans’s properties. The airspace leasing function generated about $25 million last year with the leasing of airspace beneath viaducts for parking lots, leasing airspace over freeways, and leasing ROW for telecommunication antennas. Revenues from this program function have increased 7% over the last 10 years. The telecommunication program started in 1991, making Caltrans one of the pioneers in the U.S.



Source: Caltrans (2010)

Figure 3.2: California DOT's Property Management Website

Caltrans's property management function was set up 7 years ago. This function acquires and manages land that will not be used immediately for Caltrans projects. This function has secured about $12 million in revenue per year, mostly from the leasing of property in two significant corridors owned by Caltrans. One of these corridors, which has about 400–500 housing units, is located in Los Angeles and has been owned by Caltrans since the 1970s. The excess land sales function is responsible for lands or properties that are not needed or will not be used within 20 years. In 2010, this function secured nearly $11.5 million in revenue that came from selling 290 parcels. Excess land or properties are identified through an annual systematic review of all land/property inventories relative to the land/property requirements included in Caltrans's 20-year construction plan. Caltrans is not allowed to purchase any excess property besides what is required for a specific project. Furthermore, the California legislature passed AB 1020 about 3 years ago, which established a 10-year window for Caltrans to hold a property for a project. If the property is not developed in 10 years, the property has to be sold at the original purchase price to the land owner.

Caltrans has about 12 managers and 48 employees in 12 districts involved in property management. The staff and the managers, however, are not dedicated 100% to the property management program as they have other administrative duties as well. Caltrans developed a property database in 1982, but the database is neither user-friendly (i.e., Cobalt-based) nor easily updated. Therefore, it is not widely used in the day-to-day property management program.

Caltrans currently has about 3,500 parcels that were acquired for future projects. Of these 3,500 parcels, 1,500 parcels are cleared and not available, 1,000 are residential properties, and 1,500 comprise residential and parking leases. In addition, Caltrans has identified 1,500 potential airspace for leases, of which 1,200 are under lease. In the airspace lease negotiation process, Caltrans is only allowed to consider market value in its cost-benefit analysis thus, no social or environmental benefits can be converted into monetary value and be considered. Then, both the FHWA and Caltrans have to approve the process and the site license agreement, which typically guarantees the site for 5 years and allows for five 5-year renewals. Furthermore, any air space lease in excess of 5 years has to be approved by the California Transportation Commission (CTC).

In terms of major barriers and challenges in implementing a successful property management program, Caltrans emphasized that the major objective of the agency is to promote an efficient and safe transportation system. Therefore, any ROW or airspace usage that may jeopardize road safety and create a hazardous situation would not be considered. Prior to any agreement, Caltrans thus looks to the district advisor for help identifying and assessing potential risks.

In the case of land swap transactions, Caltrans only has the authority to swap land lots. The agency swaps about 10–20 lots per year. California legislators have attempted to pass a bill that will allow Caltrans to barter maintenance facilities through a competitive bidding process. Caltrans is very supportive of this legislation. Caltrans has 350 maintenance facilities of which 25 have been identified as potential barter transactions. In general, these facilities are old and on sites with access problems. If the bill passes, Caltrans will specify the design of the new maintenance facility. The private party will be required to construct the new facility according to Caltrans's design guidelines and the exchange will be conducted upon completion of the facility. Caltrans will benefit from acquiring a new and updated facility. A barter transaction, however, can be very complex and complicated. Finally, all revenues generated from Caltrans's property management program go to the Public Transportation Account.

In Texas, a number of successful facility barter transactions have been performed by TxDOT. For example, one of the barter transactions occurred in San Antonio and took 2 years to complete. The transaction involved the seven-acre TxDOT Boerne Maintenance Facility that was located in an incompatible "industrial" area and adjacent to a supermarket and apartment complex. The supermarket wanted the Boerne site in order to expand the supermarket and construct a parking lot. The supermarket proposed to swap the Boerne site for a maintenance office and storage facility located on a 13-acre lot in an outlying area adjacent to an industrial/business park. The supermarket paid for the construction of the facility. The only costs incurred by TxDOT were $30,000–$40,000 for remediating hazardous materials on the old site. The new TxDOT facility would have cost $1.7–$1.8 million given site acquisition and office improvements. Furthermore, TxDOT could remain in the Boerne facility until the new facility was completed to TxDOT's satisfaction. The City of Boerne had to make a few minor utility investments to serve the new TxDOT facility (Susan Combs, 2001). Another barter transaction was initiated in 1991 when the TxDOT Laredo District received nine responses to a request for proposal (RFP) for a barter transaction. TxDOT wanted to replace an existing facility and secure sufficient space to build a new district office. TxDOT finally exchanged 11.7 acres and a maintenance facility for 32 acres in an outlying location and an improved $1.0 million maintenance office (Susan Combs, 2001). In these cases, all risks associated with the transaction and the facility—e.g., procurement of zoning, permits, and utility extensions—were defrayed and TxDOT also incurred no cash costs (Susan Combs, 2001). The TxDOT engineers emphasized the importance of having a strong and well-financed counter party with proven capability to conduct the transaction to ensure a successful outcome. In addition, TxDOT had about 130 active lease agreements associated with temporarily surplus ROW during FY 2009–2010. The lease agreements comprised different uses and generated about $1.1 million in revenues (Personal Communication with TxDOT, 2011).

3.1.1.9 Concluding Remarks

When implementing a property management program, TxDOT needs to

- develop and establish a systematic and comprehensive property evaluation process,
- train staff,

- invest in information systems (e.g., website, database, and GIS) capable of rendering real-time information and analysis to facilitate the decision-making process, and
- involve the State Department of Justice (DOJ), as well as legal counsels, to advise and review the written agreements with private parties and to minimize any potential risks and undesired liability to the DOT.

Furthermore, some properties' and buildings' features determine the feasibility of and interest of developers in acquiring, leasing, or bartering transactions. Property features/characteristics include:

- the location, with investors often being interested in prime locations,
- the age of the facility, which has implications for maintenance costs, and
- whether surrounding land uses are compatible given the proposed new land use.

3.1.2 Rest Areas

Rest areas are a component of the highway system, and the responsibility for these facilities lies primarily with the DOTs. An AASHTO survey revealed that significant maintenance costs are obligating several DOTs (e.g., Arizona, New Mexico, California, Colorado, Georgia, Kentucky, and Virginia) to close some of their rest areas. Moreover, concerns have been raised about security and cleanliness of some rest areas. In these cases the value of the rest areas in ensuring a safe and quality road trip is questionable. Thus, funding for rest area improvements is fundamental. Privatization or allowing vending and advertising could provide some funding. TxDOT owns 92 facilities (i.e., rest areas and information centers) that cost $17,000/month to operate (Personal Communication with TxDOT, 2010). TxDOT makes every effort to maintain its rest areas, ensuring that they are open and providing good services to the traveling public.

3.1.2.1 Technical Feasibility

Rest area commercialization or privatization is a relatively simple VEA and does not demand any complex technical solution or investment. It is essential, however, that TxDOT has data available regarding usage of and traffic passing by existing rest areas to attract investors. Another important factor is the availability of in-house staff to conduct and oversee the entire process.

3.1.2.2 Political/Public Concerns

Rest area commercialization or privatization is very controversial and has resulted in many discussions and debates at the federal level. Some DOTs have argued for a change to the legislation to allow for commercial and private activities at rest areas along federal and state highways to guarantee good service and comfort for the users. On the other hand, business owners and communities along the highways have pressured lawmakers to maintain the status quo, alleging that the privatization of rest areas would ruin their businesses and only source of income.

3.1.2.3 Legal Considerations

The privatization and commercialization of rest areas involve major legal issues and considerations. Federal law currently prohibits TxDOT from privatizing and commercializing rest areas along interstate highways. According to TxDOT, the Department of Assistive and Rehabilitative Services is the only agency that can use federal properties for vending (e.g., blind vendors). As mentioned before, this topic has been debated extensively. Legislators have expressed concern that by allowing business opportunities at rest areas, the DOT's focus would change from efficient transportation to business profitability. In addition, the public may perceive the privatization or commercialization of rest areas as unfair competition with local businesses—potentially affecting these businesses negatively.

Finally, the Randolph Sheppard Act does not apply to turnpikes (toll roads) and state roads. Basically, safety rest areas located on non-interstate highways that, therefore, were built using state and/or private funds (i.e., without federal funds) can be commercialized. TC §202.055 allows the DOT to lease a rest area along a toll road or state highway to a private entity engaging in sales, services, or other commercial activities that serve the travelling public.

3.1.2.4 Financial/Economic Feasibility

In the case of rest areas, TxDOT estimated that one pair of facilities cost about \$12–\$15 million to build and on average \$17,000 per facility to operate. The number of cars passing by and stopping determines the feasibility of attracting private sector investments. According to TxDOT, rest areas in remote areas will thus not be financially attractive to private investors because of the potentially low patronage coupled with high operation and maintenance costs (e.g., locating staff, materials, electricity, etc.).

3.1.2.5 Environmental Considerations

TxDOT should ensure that the design of "private" rest areas complies with the agency's and state's environmental standards and sustainability goals, as well as NEPA. Because the majority of TxDOT's rest areas are located in remote or semi-rural locations, attention must be paid to water use, such as waste and storm water treatment, reuse, and disposal. TxDOT should not only provide guidelines for and requirement of compliance, but should also oversee the design and construction or retrofit of the facilities. Furthermore, TxDOT can employ other VEAs such as renewable energy (see subsequent sections) to reduce its costs, its carbon footprint and to promote awareness of clean energy sources, sustainability, and environmental protection. TxDOT has already invested in a number of innovative projects to mitigate environmental concerns at its rest areas such as a rain water harvesting system (to use for irrigation), a waste water treatment system, solar panels, and wind turbines.

3.1.2.6 Potential Social Impacts/Benefits

The privatization and commercialization of rest areas may result in competition between the privatized rest area and nearby businesses. Small roadside communities that rely on travelers' expenditure (e.g., for gas and food, lodging, etc.) may be financially impacted. On the other hand, well-serviced and interactive rest areas and welcome centers can potentially enhance the tourism market, creating jobs, and therefore helping to develop rural regions (FHWA, 1996).

3.1.2.7 Safety Considerations

Rest areas are essential to the safety of road users. Caltrans states that

> rest areas are an important part of Caltrans' efforts to ensure traveler safety. They provide clean, safe and comfortable places for travelers to rest and manage their needs. Attractive and useful, rest areas encourage travelers to use a safe location off the roadway to take a break and return more alert to the highway (Personal Communication with Caltrans, 2010).

In addition, the research conducted by the National Center on Sleep Disorders Research (NCSDR) and show the National Highway Traffic Safety Administration (NHTSA) shows that "drowsy driving is a serious problem that leads to thousands of automobile crashes each year" (NCSDR/NHTSA, 2010). Furthermore, a study conducted by Michigan State University and confirmed by the Minnesota DOT showed a direct relation between safety rest area spacing and vehicle crashes (SRF, 2007). The study thus recommended that (a) rest areas should provide good service to ensure that they are attractive, (b) closed ones should be re-opened, and (c) investments in new ones should be made. Allowing private and commercial rest areas would not only raise the availability of these facilities (i.e., number of rest areas) but enhance the service and increase the attractiveness, thereby contributing to a better and safer highway system.

3.1.2.8 Examples

An important example of how to extract value from rest areas is presented by the Oasis complex in Illinois, which is composed of seven private and commercialized rest areas along the I-294/94, I-90, and I-88 tollways. The O'Hare Oasis (see Figure 3.3), located on the I-294 tollway at milepost 38, offers several services, such as a gas station, car wash, food court, shopping, and an ATM.

In Delaware, a 42,000 square foot welcome center (see Figure 3.4) is part of the busy I-95 corridor. The construction of the center, which includes a mini-mall, rest area, and gas station, cost about $35 million (2010) and was totally paid for by the developer. Furthermore, the 35-year lease contract provides the State of Delaware a percentage of the revenues from gas, food, and other goods sold, with $1.6 million in revenue guaranteed.

Source: Wikipedia—"Illinois Tollway oasis" (2010)

Figure 3.3: O'Hare Rest Area in Illinois

Photo courtesy of HMSHost Corporation

Source: Stateline (2010)

Figure 3.4: IH 95 Rest Area in Delaware

To overcome the lack of rest areas and the barriers to rest area privatization, as well as to reduce the financial and administrative costs to state DOTs, the FHWA launched the Interstate Oasis Program (see Figure 3.5), a public-private partnership, in 2006. The Interstate Oasis is defined by the FHWA as an off-freeway facility that aims to supplement the public rest area. To qualify as an Interstate Oasis, the facility has to comply with a list of requirements and specifications, including a standardized design, offering of products and services to the public, 24-hour access to restrooms, and parking for autos and heavy trucks. Furthermore, a specific and unique logo has to be adopted to identify the facilities that are part of the program. The blue signs that indicate the location of the Oasis facilities also have to meet certain requirements (Figure 3.6).

Source: Kalla (2006)

Figure 3.5: Example of FHWA Interstate Oasis Program

Source: Kalla (2006)

Figure 3.6: Blue Sign Template of FHWA Interstate Oasis Program

Another opportunity to explore at rest areas arises from the increase in electrical vehicles (EV) and plug-in hybrid electrical vehicles (PHEV). Charging facilities could be installed at rest areas to meet the increasing demand for and availability of EV and PHEV, thereby incentivizing, and supporting the users of "green" cars.

3.1.2.9 Concluding Remarks

Rest areas are fundamental and critical to drivers' safety. On the other hand, rest area maintenance and construction require funding that could be spent on road maintenance and improvements. Rest area privatization and/or commercialization could thus alleviate some budget concerns, but more importantly promote better service and more attractive rest stops.

This VEA, however, faces some legal barriers that prohibit most commercial activities on facilities funded with federal dollar (e.g., the interstate system). TxDOT can implement renewable energy sources to reduce maintenance cost and promote sustainability. Participating in the FHWA Interstate Oasis Program also offers an alternative to overcome legal barriers and help the agency reduce its investments in and maintenance costs of rest areas.

In the case of state and toll highways, no major legal issues prevent TxDOT from privatizing and commercializing rest areas along these roads, but the following points still warrant consideration:

- impacts on nearby community businesses,
- impact on current social projects, such as "blind vendor support,"
- traffic flow and estimated patronage of rest areas,
- minimum design requirements and specifications for private rest areas, and
- liabilities and responsibilities of all parties involved.

3.2 Airspace Leasing—Buildings

The term *airspace* refers here to the available space over a highway that can be used for construction purposes without interfering or hampering the main goal of a DOT in promoting a safe and efficient transportation system. Specifically, the highway's capacity has to be protected and preserved (FHWA, 2010).

In 1993, research conducted by the Texas Transportation Institute (TTI) reported that ROW airspace leasing programs formally began across the country in the 1970s. Since then several states have explored using the airspace above highways for revenue purposes. This VEA can be implemented in both urban and rural settings, but the characteristics and considerations of this VEA are different depending on the setup (TTI, 1993). The FHWA remarked that "airspace leasing activities tend to be concentrated in states with high population densities and high land values in urban areas" (TTI, 1993). The railroads have implemented airspace leasing above their passenger stations (TTI, 1993).

In summary, airspace leasing is a complex arrangements that concerns legal, planning, environmental, design, construction, maintenance, safety, insurance, and security requirements to be successfully implemented (FHWA, 2010).

3.2.1 Technical Feasibility

The usage of space above highways for any construction project imposes several technical challenges that have to be addressed by DOTs prior to the leasing agreement. Unforeseen future needs, such as lane expansions and clearances under the likely permanent structure, may be the primary challenge when assessing the feasibility of leasing any area over highways. Thus, it is recommended that any lease proposal be shared with all disciplines responsible for the highway system, including design, maintenance, and planning (TTI, 1993). The traffic engineers also have to review the airspace leasing proposal early on and carefully assess the future capacity of the highway (Savvides, 2005). Another concern involves the design requirements of the new structure. The road lanes dictate or at least restrain the location of the future building's foundation and columns. The design of the structure has to be conservative with long cross spans with transition beams and supports to withstand possible collisions, explosions, or terrorism attacks (Savvides, 2005). Moreover, AASHTO and the FHWA have stricter design requirements for construction over roads (TTI, 1993). The leasing agreement—and consequently the building's design and construction—has to address any concerns about public health, aesthetics, lighting, ventilation/exhaustion, drainage, vibration, noise, traffic capacity, clearance, maintenance, fire resistance, emergency services, and compatibility with the surrounding environment (Savvides, 2005). Limited access to new projects—i.e., buildings—can also hinder the viability of the project and, therefore, accessibility has to be incorporated in the project design.

Finally, construction is a challenge. The existing traffic, safety issues, and site constraints have to be analyzed and considered. Airspace leases for buildings are typically implemented in areas with high traffic volumes and congestion. Any traffic disruption would impact drivers and communities negatively. A constructability study has to be conducted, as well as early planning and a detailed scheduling routine (Savvides, 2005). TxDOT has to be aware of the potential concerns and address these as obligations and requirements in contract clauses.

3.2.2 Political/Public Concerns

Construction over highways can be controversial, resulting in political and public opposition. Visual pollution, disturbances during construction (i.e., traffic interference), impacts on the neighborhood (e.g., privacy, congestion, etc.), and a lack of transparency during the planning phase may cause public and political opposition. It is therefore important that public outreach be conducted during the planning and construction phases to avoid or minimize opposition to the project. Transparency is also essential. On the other hand, projects such as rest areas over highways are a novelty, especially for kids, and can therefore enhance the public perception of the DOT.

3.2.3 Legal Considerations

The FHWA's Airspace Guideline (23 CFR §713.203) clarifies the major considerations for airspace leasing agreements. On interstate facilities, the FHWA has to approve all airspace leases (FHWA, 2010).

TC Sub-chapter C of Chapter 202 governs leases, easements, and agreements that concern highway property. Section 202.052 *allows the department to lease a highway asset, part of the ROW, **or airspace above** or underground a highway, if the department determines that the interest to be leased will not be needed for a highway purpose during the term of the lease*. The lease may be for any purpose that is *not inconsistent* with applicable highway use under sub-section 202.052 (b), and must charge *not less than fair market value* for the highway asset in cash, services, tangible or intangible property, or any combination thereof under Sub-section 202.052 (c). Exceptions for the charges under sub-section (d) can be made for lease to a public utility provider, leases for a social, environmental, or economic mitigation purpose, or for leases to an institution of higher education.

TC § 202.053 (a) provides that TxDOT may determine all terms of the lease except for the following:

- the tenant may not be required to post a bond/security in excess of six months lease rental; and
- the lease must allow for the tenant to mortgage or pledge or grant a security interest in the leasehold to secure financing for the acquisition of the leasehold, or

construction or operations of an improvement that the lease allows (§202.053 (a) (1) and (2)).

TxDOT may not convey title to, or sever from the real property, any permanent improvement constructed on the area leased under this sub-chapter (§202.053 (b)).

The Texas Administrative Code (TAC) requires in Chapter 43, Sub-chapter 21, that structures built over the ROW shall occupy no more length of highway than authorized by the department (Rule21.605 (i)). Rule 21.605 (j) requires that the design and occupancy of such a structure over or under the ROW shall not affect the safety, appearance, or enjoyment of the highway by means of fumes, vapors, odors, droppings, or discharge from the structure. Signs and displays developed or maintained by the lessee are restricted to those indicating ownership or on-premise activities and must be authorized by the department subject to the Highway Beautification Act.

Because air space leasing involves a public asset, transparency is critical in the appraisals, negotiation, and bid lease valuations. Involvement of TxDOT's General Counsel (and on occasion the Attorney General) is recommended to review any contracts with private parties to minimize any potential risks and undesired liability to the DOT.

3.2.4 Financial/Economic Feasibility

Financial feasibility is an important factor in determining the attractiveness of implementing this application. The technical issues highlighted previously can impose significant additional construction costs. Although, from a DOT's perspective, this VEA does not demand major expenditures, besides the administration costs, the leasing price charged by the DOT to the developers will often determine the financial feasibility of the project. Both the FHWA Guidelines and Senate Bill 352 (TTI, 1993) mandate the charging of fair market price in airspace leasing agreements. The DOT has to demonstrate (and the FHWA has to approve) the potential social, environmental, or economic benefits accrued if a lower charge is levied. Most of the successful airspace leasing programs for buildings have been in urban areas, where real estate is very valuable. In rural areas, on the other hand, the construction features can be attractive and enhance business development. A long-term leasing agreement is, however, usually necessary to secure a return on investment (TTI, 1993). An example can be found in Boston, where the financial feasibility of three airspace leasing projects was only ensured by airspace premium funding granted by the city. This funding was needed because the land value in Boston at the outset of the projects was not yet high enough to spark and encourage private interest. In terms of benefits, the City of Boston could reconnect the neighbors that have been divided by the highway corridor, generate new tax revenue, and create permanent jobs with the ensuing economic development (Savvides, 2005).

3.2.5 Environmental Considerations

The environmental considerations are largely a function of the location of the airspace lease. In dense urban areas with a high concentration of buildings, the construction of additional buildings can cause a heat island and visual pollution. A minimum distance as determined by wind flow and heat simulation thus has to be maintained between buildings. In rural areas, no additional considerations or impacts besides what already applies to buildings or construction projects have to be accounted for. This includes sewage, water, electricity, trash, and construction disposal that have to be analyzed, assessed, and included in the design and specifications of all buildings and construction projects. On the other hand, constructing over highways reduces the building and city's footprint, once the highway is in place. Furthermore, occupying airspace minimizes the utilization of and need for green fields—a major consideration for green buildings and in green engineering.

3.2.6 Potential Social Impacts/Benefits

An airspace leasing program provides an opportunity for financial investment and business expansion—thereby promoting economic development (Iacono et al.) to the benefit of the city and the community. Constructing buildings over highways can also link and integrate communities that were divided by road construction projects (Savvides, 2005). On the other hand, if the airspace right is conceived and granted without a comprehensive study that includes the mitigation of potential negative impacts on nearby neighborhoods and road users public opposition can result. These impacts include traffic disruption (e.g., access and direction), shadows on neighboring facilities, visual intrusion, loss of neighbor's privacy, heat island, and a decrease in property value.

3.2.7 Safety Considerations

Traffic safety is a primary objective of any DOT. After 9/11, terrorism attacks that potentially entail catastrophe have also become a major consideration. Infrastructure assets are potential targets of terrorists. Therefore, whenever a leasing agreement is negotiated, a risk assessment has to be conducted (Broils-Cox, 2008). The FWHA has highlighted the importance of state agencies with security expertise or those responsible for critical infrastructure protection to assess and approve airspace leasing requests. If no expert is available in-house, it is recommended that an independent safety and security assessment be conducted to advise the DOT during the decision making process (FHWA, 2010). The risk assessment must cover, among other areas, the vulnerability of the structure, consequences of an attack, and the importance of the transportation facility. In response, preventive and protective measures must be considered and included within the agreement. The FHWA also stated that under no circumstances can the airspace be used for manufacturing or storing flammable, explosive, or hazardous substances (FHWA, 2010).

For airspace leasing of buildings, the tunnels are the most vulnerable in terms of safety and security. Lighting, evacuation routes, monitoring against terrorism, an effective air exchange system (e.g., exhaust emissions), explosions, car accidents, safe access, and fire protection systems (i.e., sprinklers) are important considerations in the planning and evaluation process. Furthermore, a safety analysis and plan is very important during the construction phase, as the road will still be opened to traffic (TTI, 1993). Finally, the building design has to prevent the ability to throw objects out of windows on to the highway (TTI, 1993).

3.2.8 Examples

Most of the existing airspace leases are in dense urban areas, where the airspace is leased for residential and commercial buildings, hotels, supermarkets, and garages. A few examples exist in rural or semi-rural locations, but these are less prevalent.

Caltrans has reportedly used ROW for restaurants, manufacturing, parking, mini-storage, boat launching, and community park facilities. In 1993, the program generated more than an estimated $12 million per year (TTI, 1993). However, according to Caltrans, all the revenue generated by the airspace leasing program goes to the Public Transportation Account and, thus, not to Caltrans. The state of Washington has one of the most publicized airspace leasing programs as a result of the construction of the Washington State Convention and Trade Center (see Figure 3.7) over IH 5 in Seattle. Phoenix, Denver, and Montreal (Canada) also have convention centers over freeways (TTI, 1993). In Boston (see Figure 3.8), the airspace over the Massachusetts Turnpike holds at least three formalized airspace leasing agreements for buildings. The first is the Copley Place, a 3.5 million square-feet complex constructed in 1986 that comprises a hotel, retail store, offices, parking, and housing. The second is Columbus Center, a complex of buildings that occupies seven acres divided into four parcels of air rights and totaling 1.4 million square-feet of construction. The Columbus Center consists of a hotel, restaurant, retail store, health club, residential building, and parking. The last is One Kenmore, which occupies one parcel of airspace and is still under development. When completed, One Kenmore will have 1.2 million square-feet of construction, including offices, a health club, grocery store, community center, and parking. The economic feasibility of all three projects was ensured by a grant from the City of Boston. This funding was needed because the land value in Boston was not yet high enough to spark and encourage private investment at the outset of the projects. In terms of benefits, the City of Boston could reconnect the neighborhoods that have been divided by the highway corridor, generate new tax revenue, and create permanent jobs with the developments (Savvides, 2005).

Source: Courtesy of Washington State Convention & Trade Center

Figure 3.7: Washington State Convention & Trade Center

An international example is the Malietoren edifice over the Utrechtsebaan in the Netherlands (see Figure 3.9). This building is an important architectural landmark for the city of Den Haag as it represents the city gate, where the arterials once entered the inner city (Savvides, 2005).

Finally, in Illinois a number of commercial rest areas (see Figure 3.10) that comprise the Oasis complex (total of seven rest areas) are all built over different tollways. Five of the seven rest areas were constructed in 1958 at the same time the highway was constructed. All the rest areas were redeveloped and renovated between 2003 and 2005 by a private developer. The redevelopment cost of approximately $95 million was all incurred by the developer and represented no risk and no cost to the Illinois State Toll Highway Authority (ISTHA). The deal comprises a 25-year leasing agreement in which the developer has to pay ISTHA a percentage of the vendor sales with $750,000 per year guaranteed (Joseph Ryan and John Patterson for Daily Herald, 2009). The particular architectural characteristic of the rest areas—i.e., over the highway—helps to attract visitors and customers, thereby benefiting the businesses and vendors.

Source: Savvides (2005)

Figure 3.8: Hancock Garage—Boston

Source: Savvides (2005)

Figure 3.9: Malietoren—Netherlands

Source: Wikipedia—"Illinois Tollway oasis" (2010)

Figure 3.10: Belvedere Oasis, Illinois

3.2.9 Concluding Remarks

Implementing an airspace leasing agreement for a building is a complex arrangement that requires a comprehensive assessment of the impacts on nearby communities and traffic. Site selection is crucial in determining the feasibility of this VEA. In addition, the following points have to be considered:

- the traffic and future highway needs (i.e., road expansion and clearance),
- structural design requirements and constraints (e.g., free span and clearance);
- other design requirements (e.g., access, ventilation, drainage, emergency services, and fire resistance);
- tunnel safety (e.g., lighting, ventilation, evacuation access, drainage, and fire protection);
- the building/facility cannot store flammable, hazardous, or explosive substances;
- the FHWA and AASHTO guidelines and requirements;
- disruptions during the construction of the building (e.g., noise, dust, and traffic congestion);
- after construction impacts (e.g., privacy, traffic congestion, noise, property value, shadows, heat island/wind current, and visual pollution);
- compliance with NEPA and environmental regulations;
- cost of studies assessments; and
- financial feasibility of the project.

3.3 Airspace Leasing—Parking Lot

Many urban areas (e.g., financial districts, commercial areas, and downtown areas) have inadequate parking to satisfy demand. Existing garage parking tends to be very expensive and insufficient. In addition, curb parking not only interferes with and impedes traffic flow, but also represents unsafe conditions as drivers tend to look for a parking space while driving at low speeds and making sudden maneuvers, thereby increasing the likelihood of accidents (Box, 2004). Box (2004) reported that curb parking can be directly related to 20% of all accidents on urban streets. Furthermore, studies conducted by the FHWA in 1978 found that 20% of pedestrian accidents involve people entering the street from behind parked cars. By prohibiting parking on main streets, accidents can be reduced 12% to 90% (Box, 2004). This VEA explores the use of existing areas beneath viaducts and ramps, as well as DOT land lots, as parking lots.

3.3.1 Technical Feasibility

Using airspace for a parking lot is a relatively simple application in terms of technical feasibility. This VEA may only require studies regarding appropriate information technologies and system implementation (e.g., parking meters or another system) and the parking design and arrangement to ensure orderly and functional access. Vehicle access is, however, a major concern and often determines the viability of the application. Other factors that have to be evaluated are traffic flow and people access (FHWA, 2010).

The technical requirements of the parking lot application can be easily incorporated into the planning and design of a new viaduct project without adding significant cost.

A concern with this application relates to the future need for the space or land. To avoid any inconvenience to private parties, 3- to 5-year leasing contracts are recommended, to allow for periodic assessment of traffic demand and thus highway system needs (TTI, 1993).

3.3.2 Political/Public Concerns

Because parking availability is a common concern in congested areas, any step towards increasing available parking will probably be well received by the general public. A partnership arrangement between the cities and TxDOT to assess the needs and opportunities for this application would be beneficial. If the airspace is leased to a private entity, it is essential to use a public bidding process to promote transparency and equal opportunity, as well as to effectively establish a fair market price for the leasing arrangement. On the other hand, there is a portion of the general public (i.e., environmentalists and transit providers) that views "parking unavailability" as a way to manage (i.e., reduce) single vehicle occupant use. These individuals may oppose the implementation of this VEA.

3.3.3 Legal Considerations

As noted earlier, Sub-chapter C of Chapter 202 governs leases, easements, and agreements that concern highway property. Section 202.052 *allows the department to lease a highway asset, part of the ROW, or airspace above or underground a highway, if the department determines that the interest to be leased will not be needed for a highway purpose during the term of the lease*. The lease may be for any purpose that is *not inconsistent* with applicable highway use under sub-section 202.052 (b), and must charge *not less than fair market value* for the highway asset in cash, services, tangible or intangible property, or any combination thereof under Sub-section 202.052 (c).

In addition to the FHWA requirements under 23 CFR §1.23, §710.407, and the AASHTO guidelines mentioned earlier, the leasing agreement and contract have to clearly state

- responsibilities,
- liabilities vis-à-vis conforming to current design standards,
- provisions to insure the safety and integrity of any federally funded facility,
- the leasing period,
- the leasing price,
- the price adjustment base,
- insurance requirements, and
- other considerations.

Although these leasing contracts are typically short- or mid-term agreements, the price adjustment base has to be negotiated. An escalator factor has typically been used by most DOTs, as well as the GLO for price adjustments. Involvement of TxDOT's General Counsel (and on occasion the Attorney General) is recommended to review any contracts with private parties to minimize any potential risks and undesired liability to the DOT.

3.3.4 Financial/Economic Feasibility

The implementation of this VEA is relatively simple and straightforward. It involves neither TxDOT investment nor substantial expenditures by a third party. Two different approaches are typically used: (1) entering into a partnership with cities and (2) entering into a leasing agreement with the private sector. When entering into a leasing agreement with the private sector, the fair market price has to be determined. Therefore, the financial and economic feasibility of the application will depend on the demand for parking space and the market value of the land. In general, the areas under highways used for parking are in very dense urban locations where space is scarce and land is valuable. In an economic analysis, the benefits associated with more available parking spaces and less traffic interference have to be considered, as well as cost savings in land maintenance, fewer traffic accidents, and more "taxable" land.

3.3.5 Environmental Considerations

This VEA does not impose substantial environmental impacts. However, some precautions have to be taken to avoid soil and water contamination from vehicle oil, as well as to drain the rain water to a public rainwater system.

3.3.6 Potential Social Impacts/Benefits

Parking availability is one of the factors that could directly influence the economic development in urban areas. Therefore, this VEA can be used as leverage to attract businesses to areas where a lack of parking impairs the growth of commercial activities. Economic development is associated with several social benefits, including the creation of jobs for nearby communities.

3.3.7 Safety Considerations

In general, parking lots can improve traffic safety and reduce accidents related to curb parking. However, some security measures should be implemented to protect the integrity of the viaducts and the safety of the pedestrians (users). Hence, restrictions are typically placed on the type of vehicle that can use the parking lot beneath viaducts and bridges (Broils-Cox, 2008). The FHWA prohibits any vehicle or truck carrying flammable, explosive, or hazardous materials from parking in highway airspace areas (FHWA, 2010). The leasing contract must thus contain clauses stating the specific proposed use—i.e., parking lot—and provide for immediate termination in case of violations (Broils-Cox, 2008). Also, security measures and the parking design have to be included in the contract and approved by the transportation agency's engineering, operation, and safety personnel. Available safety measures should be considered, such as access to emergency vehicles, fencing, lighting, wheel stop, curbs, and cameras for surveillance (FHWA, 2010). Access for pedestrians is also an important factor. A structure—such as a pedestrian bridge—may be required to avoid interference with the traffic flow.

3.3.8 Examples

Caltrans has extensively used airspace leasing for parking lots as a VEA (see Figure 3.11). Caltrans has entered into both long-term and short-term leasing agreements for parking. In general, the private sector has approached Caltrans to lease available spaces. Some parking lot structures are, however, leased to parking companies via a competitive bidding process for 2 or 3 years. To announce the bidding process, Caltrans employs tools such as Craigslist and email. In addition, park-and-ride lots—usually somewhat distant from downtown areas—are typically leased to independent car sellers or for community events on weekends. These park-and-ride leases usually involve community centers that are then responsible for providing security and cleaning the area. The community centers typically pay a lower rate for leasing the park-and-ride lot. Caltrans currently has around 400 parking lot leasing agreements that generate a reasonable level of income. However, all revenue generated goes to the Public Transportation Account. Concerns faced by Caltrans regarding parking lot agreements usually involve lawsuits filed against the agency for damages to vehicles parked in the parking lots. Caltrans, however, has always prevailed over such claims, because the agency not only protects itself through contract clauses, but also partners with third parties that have insurance and the financial capability to compensate the claimant.

Source: Caltrans (2009)

Figure 3.11: Parking Lot in California

Texas has some examples of parking lots beneath TxDOT highways. However, these agreements typically involve another public agency (e.g., city, court house, and DPS) and do not provide any financial payment or monetary benefit to TxDOT.

3.3.9 Concluding Remarks

Airspace leasing for parking lots is a relatively simple VEA that is mostly a function of the location (e.g., business attractiveness, demand, and accessibility) and requires some safety measures (e.g., access, fence, surveillance, curbs, prohibition of flammable substances, and some types of vehicles). Other considerations include

a. the term of the leasing agreement (3–5 years are recommended);
b. the FHWA and AASHTO guidelines and requirements;
c. the liability for damages to vehicles parked in the parking lot (contractual agreement). It is recommended that the State DOJ, as well as legal counsel, are involved to advise and review the written agreements with private parties, and minimize any potential risks and undesired liability to the DOT;
d. the reduction of congestion and accidents (relative to curb side parking); and
e. the opportunities for economic and business development.

3.4 Airspace Leasing—Utilities and Telecommunication Technologies

The use of ROW for utility accommodation has been extensively studied by researchers and federal agencies such as the FHWA and AASHTO. "Accommodating public utilities on highway right-of-way has traditionally been at no cost to the utility or only involves direct cost reimbursement for replacement ROW" (FHWA, 2000). However, in recent years renewable energy sources, such as wind turbines and photovoltaic solar panels, have provided an opportunity for states to consider the longitudinal accommodation of these technologies. In addition, new telecommunication technologies (e.g., fiber optics, cell phones, and internet wireless) have resulted in discussions and opportunities for exploring this potential VEA. In 1996, Congress passed the Telecommunication Act, allowing competition between telecommunication providers (e.g., cable, telephone, and cell phone). This competition has resulted in telecommunication providers seeking to access available strategic space to install their infrastructure. Telecommunication providers use mainly two ways to furnish their service: fiber optics and wireless. Fiber optics can be placed underground in conduits or above ground on poles, whereas wireless is transmitted by fixed antennas (FHWA—Public Roads, 2000). Because TxDOT owns ROW throughout the state, utility companies are typically interested in entering into multiple leasing agreements with the agency. Multiple leasing agreements are typically simpler and cheaper to negotiate and allow for bargaining. AASHTO introduced the concept of shared resources to supplement funding for transportation projects. Shared resources is defined as "private donations of telecommunication technology (principally fiber optic communications), and sometimes cash, in exchange for access to public right of way" (AASTHO—Shared Resources). Shared resource agreements are attractive because of the potential for additional revenue and because they can provide agencies with access to technological management tools such as Information Technology Systems (ITS).

Another example is the installation of cell-phone and wireless internet antennas along highways (mainly in rural or semi-urban areas). To furnish internet and cell-phone coverage along highways, wireless antennas do not need to be affixed to a tower, but can be placed on highway sign supports, light posts, roofs of buildings, bridges, and viaducts. In the case of bridges and viaducts, they can be a strategic and inexpensive solution for telecommunication and utility providers to overcome challenges and obstacles of crossing rivers, creeks and valleys.

3.4.1 Technical Feasibility

The main technical obstacle for leasing ROW for accommodating utilities and telecommunication technologies is future expansion of the road—specifically for buried and/or robust utility infrastructure. Furthermore, accommodating utilities crossing under highways require special considerations such as buried depth, concrete coat, and reinforcement. Hence, the implementation of this VEA along existing roads may be expensive. Similar to some of the other VEAs, the efforts and challenges are fewer when the use of ROW for utilities (e.g., underneath) is incorporated in new project planning and design. Finally, Table 3.2 highlights other likely technical issues that can be faced during the implementation of utilities in ROW.

Table 3.2: Project Structure Issues

Source: U.S. DOT (1996)

Exclusivity	Shared resource arrangements may limit access to public right-of-way to a single private sector partner in any specific segment, that is, grant exclusivity. From the public sector point of view, exclusive arrangements have both advantages (administrative ease) and disadvantages (potential constraints on competition among service providers, lower total compensation received by public sector).
Form of real property right	Shared resource arrangements can be structured in any of several legal formats (easement, lease, franchise, license) with variations in the property rights conveyed. Moreover, the property right may involve access to the right-of-way itself for privately owned infrastructure, or be limited to access (or use of) publicly owned infrastructure.
Type of consideration	Compensation to the public sector may be in the form of goods (in-kind), cash, or a combination of both. Moreover, in-kind compensation can include not only basic fiber-optic cable but also equipment to "light" the fiber, maintenance, and even operation and upgrading.
Geographic scope	Projects can be extensive in scope, covering long segments of roadway, or more focused on specific areas. The option that is best in any individual context depends on other factors, such as considerations of administrative burden, service interests of potential bidders, and private sector willingness to install infrastructure in an area larger than their primary area of interest.

3.4.2 Political/Public Concerns

A major public concern is the potential traffic disruption imposed by the construction and maintenance of the utility infrastructure along the ROW that is almost always perceived negatively by road users and nearby communities. Another issue is the "free" and unlimited access to TxDOT's ROW, property, or infrastructure by the private entity to perform construction, maintenance, repairs, and updates on its system. Table 3.3 highlights other political and legal concerns associated with this VEA. On the other hand, this VEA can enhance the services (i.e., telecommunication) provided by utility companies, mainly in rural and semi-urban areas. Therefore, not only will public acceptance likely be forthcoming, but political support can also be potentially generated. Finally, an improved telecommunication network can help TxDOT and other public agencies improve their information management systems, consequently yielding an enhanced service, an efficient maintenance program, and a better decision making process (i.e., wise use of public money).

Table 3.3: Threshold Legal and Political Issues

Source: U.S. DOT (1996)

Public sector authority to receive and/or earmark compensation	The public sector may be precluded from receiving cash payments, but may still be free to engage in barter arrangements, particularly if they are structured as procurements. In general, state departments of transportation (DOTs) have less flexibility, municipalities and authorities such as turnpike and transit agencies have greater flexibility in dealing with cash flows.
Authority to use public right-of-way for telecommunications	Shared resource arrangements may be precluded if state law mandates free access for utilities or if public agencies are not allowed to discriminate among utilities (e.g., permit access for telecommunications but disallow access for gas and sewerage).
Authority to participate in public-private partnerships	Because shared resource arrangements are a form of public-private partnering, legal authority to enter into such agreements is a basic requirement. In some cases, "implied authority" is not considered sufficient and specific legislation or "express authority" must be passed.
Political opposition from private sector competitors	Shared resource arrangements may trigger political opposition, though not necessarily prohibition, from private sector companies resisting the establishment of bypass networks that they perceive as competing with the services they offer. Opposition may be slight when the bypass system is limited to transportation needs, but it is likely to be stronger if the system supplies a greater range of public sector communications needs.
Inter-agency and political coordination	In addition to investing effort in coordination among agencies in the same political jurisdiction, the lead public agency may also have to orchestrate agreements between geographically proximate political jurisdictions to ensure continuity of fiber for their private partner(s).
Lack of private sector interest in shared resources	At its core, shared resource arrangements depend on private sector interest in expanding telecommunications infrastructure. Reluctance to enter into partnerships with public agencies for access to right-of-way may stem from insufficient market demand for increased communication capacity, cost factors such as more stringent installation specifications along roadway right-of-way, and administration on managerial burden of compliance.

3.4.3 Legal Considerations

The FHWA provides detailed guidance regarding the use of highway ROW for longitudinal accommodation of utilities along the federally funded interstate system. Also, federal resolution determines that public utilities can be treated differently than private utilities when using this ROW. In other words, public utilities are treated under the accommodation resolution, while private utilities fall under the airspace leasing regulation. The point of distinction is whether the “intended use” is in the “public interest.” The FHWA permits states to decide whether to use the utility accommodation program, as well as to develop their own accommodation policy. The FHWA, however, has to approve the state’s accommodation policy. It is also considered essential that a DOT provides equal opportunities to all utility providers or interested entities (FHWA and Public Roads, 2000).

The leasing agreement has to clearly state the responsibilities, liabilities, leasing period, leasing price, and price adjustment factor among other requirements. In long-term leasing agreements, the price adjustments are typically based on an escalator factor (TTI, 1993). Escalator factors have been used by most DOTs, as well as the GLO, for price adjustments. Leasing agreements also typically include a protective clause that comes into effect when the agreement has to be terminated (TTI, 1993). Table 3.4 describes some of the typical issues concerning shared resource contracts. However, state and federal utility accommodation policies may be out of date and not address new technologies and their requirements. Therefore, some reformulation may be required. In addition, involvement of TxDOT’s General Counsel (and on occasion the Attorney General) is recommended to review any contracts with private parties to minimize any potential risks and undesired liability to the DOT.

Table 3.4: Contract Issues

Source: U.S. DOT (1996)

Relocation	Allocation of responsibility for infrastructure relocation in case of roadway improvements affects private partner willingness to pay for right-of-way insofar as it carries a financial responsibility as well.
Liability	Similarly, allocation of legal liability among partners affects the financial risks assumed by each one. Liability includes responsibility for system repair, consequential damages (economic repercussions), and tort actions.
Procurement issues	Shared resource arrangements face many of the same issues as other procurements regarding selection and screening of private vendors or partners.
System modification	Shared resource arrangements may or may not include explicit provisions for system modification; that is, technological upgrading to keep abreast of technical improvements and expansion of capacity to meet subsequent needs.
Intellectual property	Intellectual property involves intangible components (e.g. software programs) of the operating system that might not be available to the public sector partner when the partnership is dissolved after the lease period unless specifically addressed in the contract.
Social-political issues	Social-political issues involve equity among political jurisdictions or populations segments within the right-of-way owner's domain. More specifically, two issues may affect how shared resource arrangements are structured: most-favored community issues—comparable compensation for all communities engaging in shared resource arrangements, and geographic and social equity—equitable access to and benefit from shared resource arrangements.

In Texas, TC sets out the regulations for utility accommodation. Under TC §202.092 telecommunication providers cannot place or maintain their facilities or otherwise use improvements, including structures, medians, conduits or lines, constructed or installed by the state as components of the highway system, except by lease under §202.052's provisions or an agreement under §202.093.

Section 202.093 allows TxDOT to enter into an agreement with a telecommunications provider, to place their telecommunication facilities purpose within the median of a divided state highway, or place lines within or otherwise use telecommunication facilities owned or installed by the state in or on the improved portion of the state highway, including a median, structures, equipment, conduits or any other component of the highway facility. TxDOT can enter into an agreement that provides for cash compensation or the shared use of facilities. Section 202.094 requires that before TxDOT enters into any such agreement that the agency follow a procedure using competitive sealed proposals. Section 202.093(b) also notes that this sub-chapter does not limit a telecommunications provider from placing lines or facilities in the unimproved portion of state highway ROW.

One of the major considerations for a utility location airspace lease VEA in or adjacent to the ROW is that the DOT is responsible for the cost of utility relocation (TC §203.092) if the utility is required to move. Section 203.092 (d) notes that the cost of relocation includes the entire amount paid by the utility properly attributable to the relocation less these amounts:

1. any increase in the value of the new facility;
2. the salvage value derived from the old facility; and
3. any other deduction established by regulations for federal cost participation.

Finally, environmental analysis is also a requirement for any project or activity on public land. Any project must be in compliance with NEPA.

3.4.4 Financial/Economic Feasibility

The costs associated with accommodating utilities along the ROW vary depending on

- how the utility will be placed (e.g., buried, tower, etc.);
- if it is to be accommodated in the ROW of an existing road or a new project;
- the technical requirements; and
- if it will be located in a remote or urban area.

In addition, the maintenance cost has to be factored in depending on the type of utility. All these costs are incurred by the utility provider or investor. Finally, intangible benefits such as social development, telecommunication coverage, and safety have to be appraised and considered in the economic analysis. Table 3.5 also summarizes some financial issues involved in entering into shared resource and ROW lease agreements with utilities.

As previously mentioned, DOTs have to charge a fair market price (at a minimum) when they allow private entities to use public land. Federal regulations (23 CFR 710), however, provide an exception when the DOT demonstrates—and the FHWA approves—that the activity is in the public interest, i.e., has social, environmental, or economic benefits.

Table 3.5: Financial Issues

Source: U.S. DOT (1996)

Valuation of public resources	Before entering into shared resource arrangements, the public sector needs to have some idea of the value of the assets it brings to the partnership; that is, continuous or sporadic access to its right-of-way for placement of private (communications) infrastructure.
Tax implications of shared resource projects	Partnerships between public and private entities may pose unique tax issues, particularly bond eligibility for tax-exempt status when proceeds may benefit profit-making private organizations.
Valuation of private resources	Valuation of the private resources provided in barter arrangements helps the public sector determine whether it is receiving a fair market “price” for its resource.
Public sector support costs	Although shared resource arrangements provide cash revenue or telecommunications infrastructure without public sector cash outlays, such compensation is not without cost since the public sector must use agency labor hours for administration, coordination, and oversight.

3.4.5 Environmental Considerations

An assessment of the environmental impacts is essential and has to consider the type of utility that is going to be accommodated within the ROW. For example, gas and oil pipelines may pose a risk of contamination when leaking. The FHWA, through 23 CFR §771, obligates a state to submit environmental documentation describing the purpose of using the ROW to the FHWA Division office. This documentation has to comply with NEPA requirements (FHWA, Utility Guidelines, 2009).

3.4.6 Potential Social Impacts/Benefits

The availability of wireless and cell-phone services can have an important social role in the development of remote and rural communities. Most utility services are essential and critical for social development and welfare. Furthermore, telecommunication and internet availability can play an important and beneficial role in providing education, information, and safety (e.g., tornado warnings). Finally, Intelligent Transportation Systems are facilitated by robust IT networks, thus contributing to more effective and efficient infrastructure management and better decision making (FHWA and Public Roads, 2000).

3.4.7 Safety Considerations

Regardless of whether the utility is accommodated under or above ground, implementing this VEA along existing roads always raises safety concerns. If the application does not involve the installation of a fixed structure such as towers, the major issues revolve around construction and maintenance. It is important to develop a construction plan and anticipate likely hazardous situations during construction (if the road exists already) and during maintenance. TxDOT, as the owner of the ROW and the responsible party for promoting road safety, has to require and evaluate the execution plan. Access for maintenance purposes is potentially critical and has to be considered and assessed. Antennas along the ROW may also pose hazardous obstacles for drivers. Therefore, precautionary measures have to be implemented such as designation of an installation location (i.e., the most appropriate place for installing towers) and protection barriers. On the other hand, buried utilities present no safety risk associated with car crashes. Nonetheless, considering and evaluating maintenance accessibility, security precautions, potential risks (e.g., explosions, fire, and leaks), and overall highway safety (FHWA guideline, 2009) is a fundamental step.

Having a wireless signal for cell phones along highways allows drivers to communicate accidents, animal carcasses, obstructions, and severe weather conditions, thereby enhancing the safety environment of the highway system. In addition, a wireless communication infrastructure facilitates the implementation of the Advanced Rural Transportation System (ARTS) (FHWA and Public Road, 2000). ARTS aims to improve safety and transportation services in rural areas (FHWA and Public Road, 2000). The Central Federal Lands Highway Division (CFLHD) defines the main objective of ARTS technologies as to "provide information about remote road and other transportation systems. Examples include automated road and weather conditions reporting and directional information," which can be disseminated by several methods, such as Dynamic Message Signs (DMS), 511 travel information, and Highway Advisory Radio (HAR). CFLHD also highlights the importance and value of this type of information to motorists traveling to remote and rural locations.

3.4.8 Examples

The New York State Thruway Authority uses two different types of shared resource agreements. The first involves the design, construction, maintenance, and operation of six ducts of fiber optics along its ROW. The second type of agreement is with the wireless companies that pay a monthly leasing fee in exchange for being allowed to install antennas on towers, buildings, sign posts, bridges, and undeveloped ROW of the Authority (AASHTO—Shared Resources Website).

In 1999, "[t]he Florida DOT reached a 30-year lease agreement with Lodestar Towers, Inc., allowing Lodestar Towers, Inc. to lease access to the Department's limited access ROW in return for compensation formulated as a percentage of the gross revenues received from renting antenna space to commercial wireless service providers." The public-private lease agreement was developed in compliance with the Department's Telecommunications Policy, whose goal is "to consolidate wireless tower use to the Department's limited access ROW by providing equal access and opportunity to all wireless service providers. This strategy encourages wireless service providers to collocate on towers located on the Department's limited access ROW instead of developing numerous new tower sites in local communities.

The resulting reduction of the number of towers and the location of needed towers as far from residential areas as possible facilitates the intent of the lease to support the wireless service providers while minimizing wireless tower proliferation. To date, Lodestar Towers, Inc. has constructed 26 towers on the Department's ROW. Another 22 proposed towers are under siting and design review by the Department (Florida ITS, 2001). See Figures 3.12 and 3.13.

Source: U.S. DOT (2000)

Figure 3.12: Wireless Monopole with Electrical Vault and Fencing

Source: Florida ITS (2001)

Figure 3.13: Wireless antennas attached to FDOT Tower

Caltrans received $7.3 million in revenue in FY 2008 from its airspace leasing program, of which $1.3 million came from 52 cell towers. Caltrans's Leasing Program Administration personnel regard the cost-effectiveness of cell towers to be a major benefit. Cell towers do not require extensive on-site maintenance and generate reasonable revenues (Caltrans, 2009). All revenue generated by the Caltrans leasing program, however, goes to the Public Transportation

Account and the only benefit to the Department is thus shared resources (i.e., reserved fiber optic or wire rack space (when required by the agreement). In addition, a bill (i.e., legislation determination) requires Caltrans to incur the cost of managing and administrating the program. Caltrans's airspace program for telecommunications is administered by an agent and five-person team responsible for managing the relationship with renters, those seeking business opportunities, and implementing the procedures needed for leasing (Caltrans, 2009). Most of the airspace leasing agreements involve telecommunication providers, which encompass 20 different companies. Most of the telecommunication leasing agreements are located in urban areas (about 90%) and all of them are in accordance with Caltrans's master license agreement that grants a 5-year license for a specific site, with the option to renew the license five times for 5 years each. According to Caltrans, the utility agreements have to clearly state responsibilities and liabilities for utility relocation necessitated road expansions. If not, the transportation agency has to cover the cost. Caltrans used to be able to charge for accommodating fiber optics in ROW, but the previous legislature removed that authority. The state is not receiving approximately $5 million per year for not charging for accommodating fiber optics in Caltrans's ROW.

3.4.9 Concluding Remarks

Airspace leasing for accommodating utilities and telecommunication technologies vary substantially. New communication technologies (e.g., fiber optics, cell phones, and wireless internet), as well as renewable energy technologies (e.g., solar panels and wind turbines), can potentially be implemented along TxDOT's ROW and on its land assets. The following, however, needs to be considered:

a. potential future road expansions (i.e., relocation cost);
b. the public-private partnership arrangement and the associated liabilities and responsibilities;
c. the need for private access to the ROW for utility construction and maintenance;
d. these VEAs are typically implemented in urban areas although substantial benefits can also accrue to rural areas if implemented in these areas;
e. the compensation options for TxDOT include barter (i.e., use of the infrastructure by TxDOT in exchange for the ROW access) and/or cash;
f. FHWA provides detailed guidance regarding the use of highway ROW for longitudinal accommodation of utilities and airspace leasing;
g. involvement of the State DOJ, as well as legal counsel, to advise and review the contracts with private parties, and minimize any potential risks and undesired liability to the DOT is recommended;
h. the FHWA, through 23 CFR Part 771, obligates the state to submit environmental documentation describing the purpose of using the ROW to the FHWA Division office. This documentation also has to comply with NEPA; and
i. if wireless and cell signals cover the highway network, drivers can communicate accidents, animal carcasses, obstacles, and bad conditions, thereby enhancing road safety.

3.5 Advertising

Advertising by transportation agencies has been widely discussed. For example, AASHTO acknowledges the potential and attractiveness of advertising revenue for transportation agencies (AASHTO—Advertising, 2010). Therefore, many DOTs have pursued the implementation of this VEA.

Specifically, to offset the high cost of maintaining rest areas, several states have explored advertising at rest areas and kiosks (i.e., electronic signs, brochures, and billboards) and wireless internet sponsorship as potential revenue sources. The Georgia DOT, for example, is looking for private partners to maintain rest areas in return for the right to exploit advertising space and sponsorships at the rest areas (Stateline.org, 2010). California has been considering the approval of a controversial state bill allowing advertisements on Caltrans's vehicle license plates (i.e., electronic license plates) (CSG, 2010). AASTHO has recommended and some DOTs have sold naming rights to toll roads and plazas, highway corridors, and concession areas (AASHTO—Naming Rights, 2010). Finally, some DOTs, such as Pennsylvania, California, and Florida, have pursued the use of electronic signs that alert drivers about traffic conditions, accidents, and work on the road for advertising, but this required a prior waiver of FHWA regulations.

3.5.1 Technical Feasibility

No major technical concerns or impediments hinder the implementation of advertising as a VEA. A marketing analysis and traffic flow evaluation to assess the viability and impact of the advertising location is recommended to ensure the effectiveness of the advertisement and maximize the revenue generated.

3.5.2 Political/Public Concerns

Misinterpretation of advertising material can generate public and political controversy. TxDOT thus has to carefully assess and determine acceptable advertisements (i.e., content, images, and message) to prevent any negative reactions. These concerns are exacerbated whenever generated revenue is involved. On the other hand, state DOTs and federal agencies have successfully used advertisement signs, posters, billboards, and other channels to share information about public services, conduct public outreach, and educate the public (e.g., "Don't Drink and Drive" in Texas) (FHWA, 1996).

3.5.3 Legal Considerations

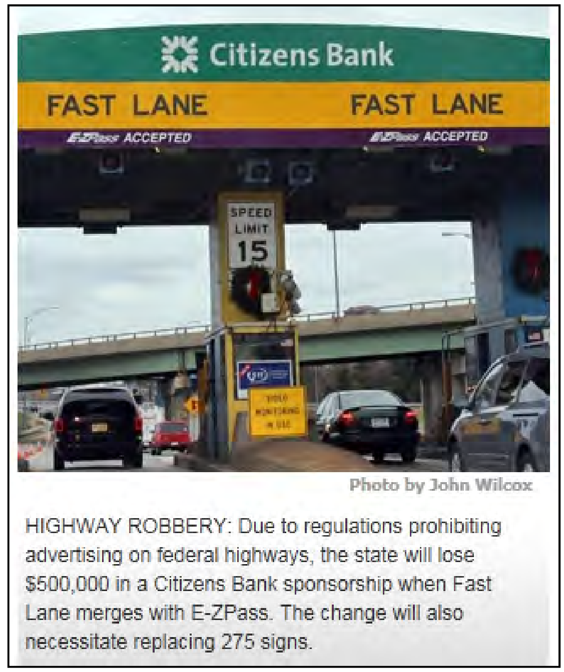
Different advertising regulations pertain to interstate highways, state roads, and turnpikes (i.e., toll roads). For example, the FHWA regulates the number, size, and location of advertisement signs through its advertising control program. In addition, several FHWA regulations prevent advertisements on overhead and roadside signs. Furthermore, state laws can also exacerbate the challenges and obstacles in implementing an advertising program (CSG, 2010). In Texas, "TxDOT regulates the display of off-premise outdoor advertising signs along highways regulated by the Highway Beautification Act (HBA) and all other highways and roads located outside of the corporate limits of cities, towns and villages in Texas under the State Rural Roads Act (RRA)" (TxDOT, 2010).

Section 391.001 TC sets out the definitions and regulations for highway beautification in Texas. Section 391.002 describes the purpose of the chapter, which was to comply with—and is conditioned on—the Highway Beautification Act of 1965 (23 U.S.C. §131, §136, and §319). Section (b)(1) notes the need to regulate the erection and maintenance of outdoor advertising adjacent to the interstate and primary system to promote the health, safety, welfare, morals, convenience, and enjoyment of the traveling public, as well as to protect the public investment in the interstate and primary systems.

TC §202.060 also allows the Commission to adopt rules to implement a pilot project for leasing state highway ROW, subject to federal regulation of outdoor advertising, for *commercial* *advertising by means of a floral mosaic living logo* in a county with a population of over 500,000.

Parties interested in outdoor advertising should review all regulations pertaining to signs on the specific site and then obtain the appropriate license and permit, if necessary. In addition, some modes of advertising require approval from the federal government before they can be used, such as electronic highway signs (CSG, 2010).

On the other hand, some sponsorships on federal highways are illegal, because they may be perceived as government endorsement (FHWA, 1996). In general, states allow sponsorship for litter removal only under a well-established program (i.e., Adopt-A-Highway Litter Removal Service of America, Inc. and Adopt-A-Highway Maintenance Corporation). An example of how legislative considerations can impact the implementation of this VEA occurred in Boston where a turnpike became part of the Massachusetts DOT, which required "the state to end Citizens Bank's $500,000-a-year Fast Lane sponsorship, because the Massachusetts Turnpike now falls under federal guidelines that forbid advertising on federal highways" (see Figure 3.14) (Chabot, 2010). Similarly, some naming rights of public assets may also face legal barriers and considerations because of sponsorship concerns.



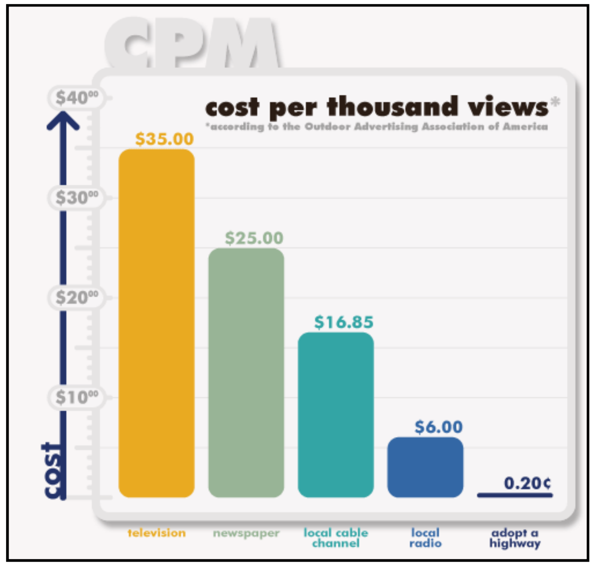
Source: Chabot (2010)

Figure 3.14: Fast Lane Sponsorship of Massachusetts Turnpike

3.5.4 Financial/Economic Feasibility

Research conducted by AASTHO and TTI highlighted the importance of including the costs of administering and regulating advertising programs in the feasibility study to determine the fees charged. Some TxDOT representatives, for example, believe that the administrative cost of advertisements at rest areas alone is prohibitive. It is believed that the cost associated with the staff required to manage several small advertising contracts will not be offset by the revenue and profits from the advertisements. Furthermore, the technology or means used to advertise can increase costs substantially. For example, rest area panels and brochures are less expensive than TV screens and electronic boards. The revenue generated by the former is, however, also less than the latter. Pennsylvania DOT estimated that approximately $150 million could be generated annually through advertising on electronic highway signs that inform drivers of accidents, traffic congestion, and construction (CSG, 2010).

Naming rights and sponsorships can also generate substantial revenues and have lower cost per number views (see Figure 3.15). Although the revenue generated through naming rights is likely insufficient to fund large transportation capital projects, their stability and predictability make this application attractive for DOTs. In addition, the revenue can be used to fund a portion of the operation and maintenance of the transportation system (AASTHO—Naming Rights, 2010). Another benefit of these programs (e.g., litter removal sponsorship) is the cost savings that can be generated through reduced mowing activities and roadside maintenance.



Source: Adopt-a-Highway Program (2011)

Figure 3.15: Cost of Advertising per Thousand Views

Finally, the visibility along highways for advertising can help promote businesses in rural areas, thereby helping the development of these communities. This benefit has to be appraised and accounted for in an economic analysis.

3.5.5 Environmental Considerations

In general, advertising does not impose substantial environmental impacts besides the aesthetic impacts associated with certain types of advertising (e.g., billboards). This application, however, can also be used for educational purposes such as environmental conservation, wildlife preservation, and global warming awareness. Furthermore, some advertising means can be linked to sustainable resource usage. For example, electronic panels can be connected to a renewable energy source, brochures can be made from recycled paper, and signs and billboards can be constructed with recycled materials (e.g., wood and aluminum).

3.5.6 Potential Social Impacts/Benefits

In addition to generating revenues, advertising can be used to share ideas, engage public participation in social projects, and conduct public outreach. Especially in semi-rural and rural locations, advertising can help small communities to promote points of interest (i.e., tourist attractions, and typical activities and businesses in their community), thus helping local development.

Litter removal sponsorship is also an example of how advertising can promote social and environmental benefits. Making the roadside litter-free helps to preserve the fauna and flora, prevent soil and water contamination, prevent proliferation of insects and, consequently, diseases, and generate local employment.

3.5.7 Safety Considerations

Safety is a major concern when using advertising in highway ROW. The FHWA and the AAA Foundation for Traffic Safety argue that advertising can distract drivers and, consequently, cause accidents (CSG, 2010). Furthermore, the signs and billboards have to be located outside the clear zone. On the other hand, brochures, web sites, and other advertising means can be used to educate, warn, and guide drivers toward safer behavior (e.g., "don't drink and drive," "no texting," "buckle up," and car maintenance).

3.5.8 Examples

Advertising on highway assets—i.e., non-federal highway ROW, bridges, and rest areas—has been implemented in some areas. Several examples thus exist that illustrate the applicability of different advertising means as a VEA. The Pennsylvania Turnpike, for example, has permitted advertisements on tollbooth windows and ticket machines, which generated about $519,000 in 2009 (CSG, 2010). Miami-Dade Transit implemented a naming program for toll plazas and subway stations. Similarly, DOTs can implement naming rights on non-federal rest areas, kiosks, and rest stops that will allow companies or individuals to have their names associated with the asset. The funds can then be used to pay for maintaining (i.e., sponsorship) or even constructing and retrofitting the asset. The Florida DOT has recently started to manage its Tourist-Oriented Directional Sign (TODS) program in-house, after the contract with Florida Interstate Logos expired.

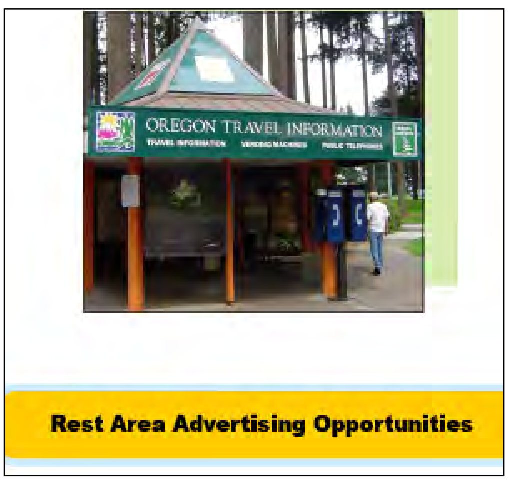
To reflect a more realistic value of advertisements for businesses, FDOT increased the price of blue signs by nearly 200% in some cases. The new price varies according to location, traffic volume, and market condition (AASHTO—Journal, 2010). The Georgia DOT (GDOT) has sought opportunities to raise revenue through advertising and has estimated that more than $1.4 million can be generated. The intention is to place advertisements on kiosks, TVs, backlit signs, and electronic posters at rest areas. GDOT, however, regards wireless internet sponsorship as the most lucrative application. The idea is that travelers would watch commercials and advertisements on their computer in exchange for free internet access. These websites can be used to inform and help travelers plan their trip and stops, as well as provide information about points of interest and attractions. The websites can also contain advertising for lodging, restaurants, and gas stations along a specific route.

In Texas, all rest areas and travel information centers currently provide free wireless access to travelers as an incentive to stop along the highway and rest for a while. The wireless service is provided and managed by a third party that TxDOT pays $100,000 per month. TxDOT measures and monitors the quality and usage of the service, penalizing the provider if the service is unavailable or decreases in quality for more than 5 days. TxDOT also has a website (i.e., Tex Treks) (see Figure 3.16) that appears when travelers access the wireless service and informs users about road conditions, provides travel tips, and suggests places to stay. The wireless service provider currently allows advertisements on the website and receives all advertising revenue. TxDOT is exploring different options to share in the advertising revenue generated. One option is to offset the costs of providing and maintaining the internet service with advertising revenue generated.

Source: TexTrek (2010)

Figure 3.16: Tex Treks Website

In Oregon and Washington (see Figures 3.17 and 3.18, respectively), brochures and panels are used as advertising mediums. Rest areas are equipped with brochure dispensers that are rented to vendors and companies. The vendor can rent dispenser space at a rest area or at several rest areas (i.e., packages). The rent price varies depending on the number of rest areas in the rent package and/or the size of the panel (see Figure 3.18).



Source: OTIC (2010)

Figure 3.17: Oregon Travel Information Center

Source: Storeyco (2010)

Figure 3.18: Example of Washington Rest Area Brochure

Another interesting variation of this VEA is found in Toronto, Canada, where the vegetation along the highway that links the international airport to downtown is used to advertise companies (see Figure 3.19).

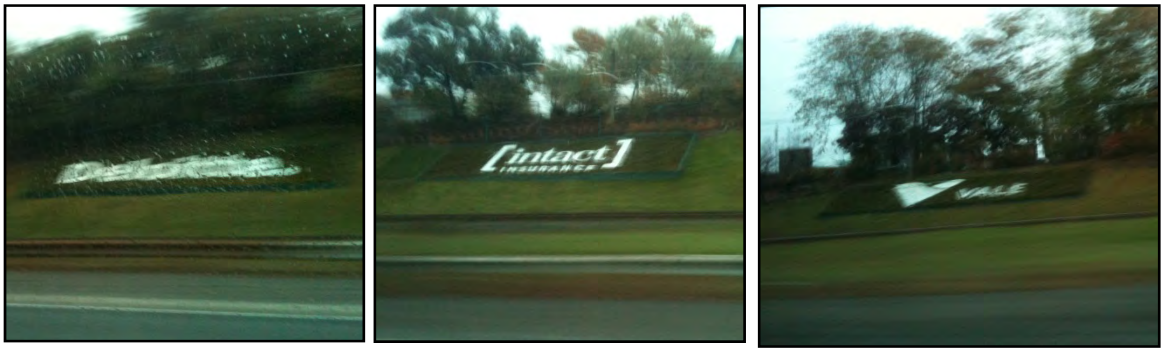
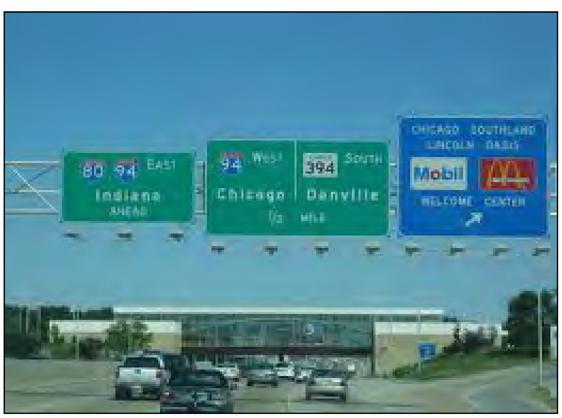


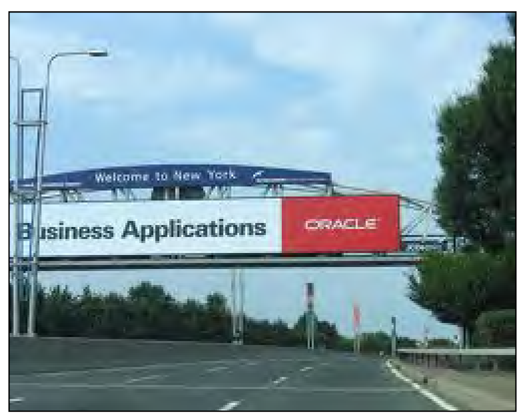
Figure 3.19: Advertising along ROW in Toronto, Canada

TOD signs (i.e., blue or logo signs), however, are the most common advertising type encountered along U.S. highways (see Figure 3.20) and are used mainly to inform travelers about services along the road. However, some other sign templates are also used (see Figure 3.21). In Texas, TxDOT has a partnership with a Texas-based company called LoneStar Logos & Signs L.L.C. (see Figure 3.22) that is responsible for providing motorists "useful information about services and destinations while traveling Texas highways" (LoneStar Logos & Signs). LoneStar Logos & Signs has a diversified portfolio of sign programs (i.e., logo signs, tourism directional signs, and mall/retailer signs), which encompasses "companies of all sizes, from small, locally-owned family businesses to large national and international corporations" (LoneStar Logos & Signs). The main objective of this partnership is "to connect motorists with information about nearby services and destinations in an effort to bring comfort to drivers and passengers and make Texas highways safer and easier to navigate" (LoneStar Logos & Signs). LoneStar also highlights the major benefits of this program as offering more information thereby enhancing driver safety, increasing business for participant destinations, and providing the best service and value possible to the State of Texas.



Source: AARoads (2010)

Figure 3.20: Illinois IH 80



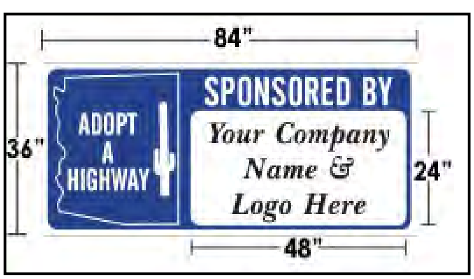
Source: AARoads (2010)

Figure 3.21: New York IH 878

Source: LoneStar Logo & Signs (2011)

Figure 3.22: Blue Sign Template of LoneStar Logos

In general, two nationwide programs provide opportunities for sponsorship for litter removal and roadside maintenance. The first program, Adopt A Highway Maintenance Corporation (AHMC), "provides your company or organization the opportunity to brand your company name and logo while supporting the community your customers live and work in. The best part of the Adopt A Highway/Sponsor a Highway program is, AHMC does all the work, while your company gets all the positive recognition" (Adoptahighway.com). The states participating in this program include Arizona, California, Colorado, Connecticut, Delaware, Georgia, Indiana, Kansas, Maryland, Massachusetts, Michigan, Nevada, New Hampshire, New Jersey, New York, Rhode Island, Utah, and Washington. The second program is called Adopt A Highway—Litter Removal Service of America (AAH-LRSA). It has been in business for 22 years and "provides an opportunity for businesses to financially sponsor litter removal along America's busiest highways while receiving recognition. Companies that make a commitment to finance litter pick up along a stretch of highway, receive a sign that identifies them as a community minded, environmentally conscious business. Our professional crews perform the cleanup of adopted/sponsored segments." AAH-LRSA is responsible for all arrangements, including 1) determination of desirable and available sites, 2) provision of DOT's custom panel for the sign, 3) execution of all work (i.e., cleaning and maintaining), 4) coordination of all activities with the DOT, and 5) documentation of all services (Adoptahighway.net). The states that are participating in this program include Arizona, California, Connecticut, Indiana, Kansas, Maryland, Massachusetts, Missouri, Nevada, New Hampshire, New Jersey, New York, Rhode Island, and Washington. Regardless of the program, each DOT has its own unique sign patterns (see Figures 3.23 through 3.27).



Source: Adopt-a-Highway Program (2011)

Figure 3.23: Arizona's Sign Pattern

Source: Adopt-a-Highway Program (2011)

Figure 3.24: California's Sign Pattern

Source: Adopt-a-Highway Program (2011)

Figure 3.25: Sponsorship Sign in Arizona

Source: Adopt-a-Highway Program (2011)

Figure 3.26: Sponsorship Sign in Massachusetts

Source: Adopt-a-Highway Program (2011)

Figure 3.27: Sponsorship Sign in Maryland

Another type of sponsorship that can be used by TxDOT is Adopt-A-Watt. Similar to Adopt-a-Highway, in an Adopt-a-Watt agreement companies can sponsor or fund a clean energy project in exchange for having their name advertised and acknowledged. A sign template that complies with FHWA Acknowledgment Sign Standards is provided (see Figure 3.28). The two most popular sponsorship programs are Sponsor-able Photo-Voltaic Light (SPVL) and Sponsor-able Photo-Voltaic Display (SPVD). For solar lights, the sponsorship fees start at $2,000 per year, while for solar arrays the sponsorship fees start at $10,000 per year. Both programs require a 3-year minimum commitment. Several Adopt-a-Watt projects have been implemented nationwide at rest areas, travels plazas, bridges, tunnels, airports, sport/entertainment complexes, and rail/bus stops. Figure 3.29 shows an example of an SPVD at the JFK International Airport.

Source: AAW (2011)

Figure 3.28: Adopt-a-Watt Sign Template

Source: AAW (2011)

Figure 3.29: SPVD at JFK International Airport

Finally, naming rights have been used by the private and public sectors to generate revenue. Here, a private company/individual pays a naming right fee in exchange for having its name and/or logo associated with the property (e.g., rest area, toll plaza, bridge, highway, or train station).

3.5.9 Concluding Remarks

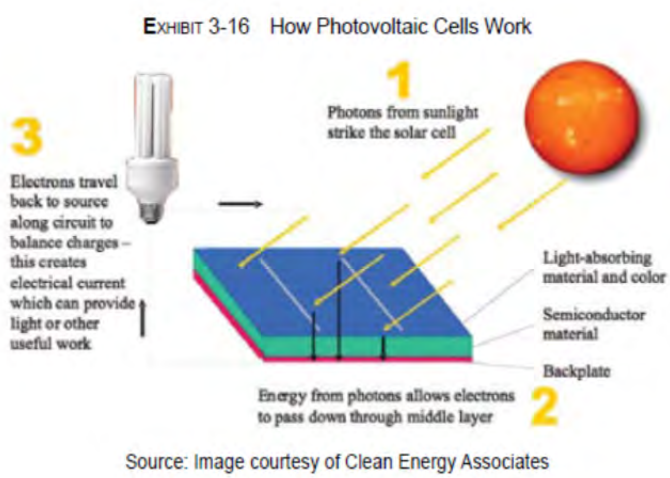
Advertising as a VEA is fairly simple, but a number of considerations prevail, including the following:

a. Legal and regulatory barriers:
   - Federal law prevents adverting on Interstate ROW.
   - In Texas, the Highway Beautification Act (HBA) and State Rural Roads Act (RRA) regulate the use of billboards and signs,

b. Different legal considerations for advertising and sponsorship. Sponsorship programs for litter removal and highway maintenance are allowed and can help offset costs.
c. Most advertising programs have high administration costs when compared to the revenues generated, although some advertising means are more cost-effective than others,
d. Advertisements are only effective in areas with high visibility (e.g., people or vehicles),
e. Advertisements can be used for public outreach and to promote public service, and
f. Finally, a major concern with advertising on highways is driver distraction.

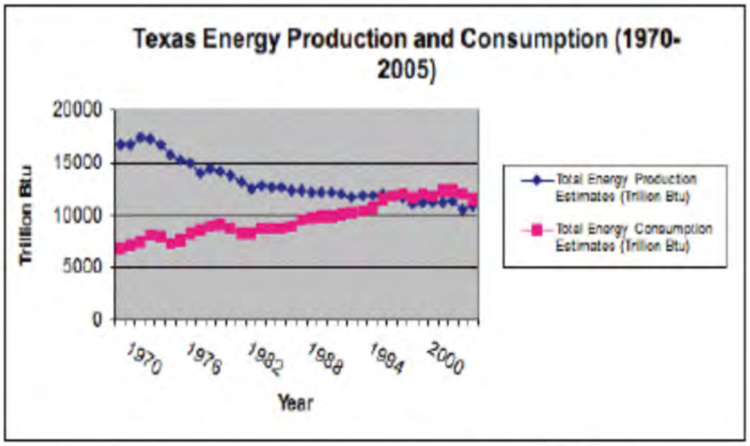
3.6 Solar Panels

Solar photovoltaic panels are composed of cells that convert sunlight into electricity through the photoelectric effect (see Figure 3.30). Solar panels have no moving parts, do not require water, do not make noise, and do not produce any waste or emissions when producing electricity (SECO Website). Solar panels have been widely used on residential and commercial buildings and are a key component of the U.S. national strategy for reducing the nation's carbon footprint and promoting renewable energy (SECO Website). In addition, the increasing costs and price volatility of fossil fuels, concerns about global climate change, lower solar energy equipment and technology prices, and federal and state incentives have enhanced solar activity (SECO, 2008). This activity has resulted in the construction of many solar power plants nationwide, including in Texas. In terms of renewable energy sources, solar has the greatest potential in Texas (see Figure 3.31).



Source: SECO (2008)

Figure 3.30: How Photovoltaic Cells Work



Source: Energy Prod Estimates: http://www.eia.doe.gov/emeu/states/sep_prod/P7/PDF/P7_tx.pdf
Consumption Estimates: http://www.eia.doe.gov/emeu/states/sep_use/total/use_tot_tx.html

Source: SECO (2008)

Figure 3.31: Texas Energy Production and Consumption

Electricity is essential to economic development and welfare and any electricity shortage or price volatility can be catastrophic for an economy.

It has been projected that the traditional energy sources (i.e., coal, crude oil and natural gas) will not be sufficient to meet the growing energy demand. Moreover, the federal government has continuously expressed the need for the country to be less dependent on fossil fuels and foreign oil.

TxDOT spends more than $200 million annually on electricity (TxDOT, 2009). Renewable energy resources may thus present an opportunity to reduce electricity costs, protect the agency against the volatility of electricity prices, or generate revenues.

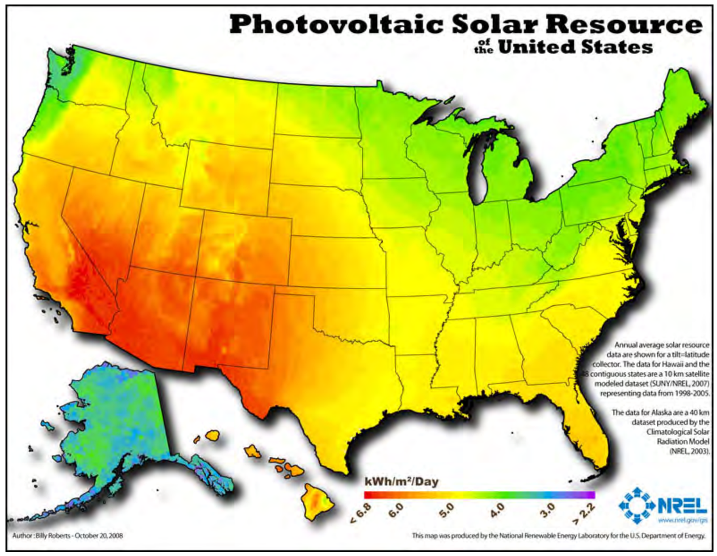
Two different VEAs are herein envisioned by TxDOT for the use of solar panels. First, solar panels can be installed along highway ROW to generate electricity for public lighting, houses, or even nearby communities. Second, solar panels can be installed on TxDOT's buildings, such as offices, warehouses, and rest areas. Both these approaches can reduce electricity expenditures, as well as the agency's carbon footprint. The new trend in electric car usage also offers an opportunity for exploring the use of solar panels as a revenue stream. Because electric cars are range-limited, some DOTs are looking at implementing recharge stations fueled by solar panels along highways and at rest areas to meet electricity demand of electric cars. At rest areas, solar energy can also be used to provide electricity for recreational vehicles (RVs) and trucks.

3.6.1 Technical Feasibility

The major advantages of solar panel systems are their mobility and scalability. Solar panels can be installed near the end user and to any desirable scale (SECO, 2008), reducing both the infrastructure investment—e.g., transmission lines—and the loss of electricity due to heating along transmission lines. Moreover, solar panels can operate off-grid—i.e., not connected to the existing electricity grid—as stand-alone systems. As stand-alone systems, solar panels only operate during sunlight and, thus, batteries have to be incorporated into the system to ensure full independence from the grid (i.e., electricity) at any time. One possibility to reduce or avoid the use of batteries is the adoption of a hybrid and stand-alone electricity generator system—i.e., incorporate solar panels and wind turbines into one integral system (SECO, 2010).

Another benefit of using solar panels is that their production capability—i.e., during the day—corresponds with the daily and seasonal energy demand in Texas, when the price of purchasing electricity from the grid is highest (Borestein, 2008). On the other hand, solar panels have low energy density production. A considerable area is thus required to produce a large amount of electricity (SECO, 2010). This characteristic is one of three barriers that have prevented widespread solar utilization (SECO, 2008).

Even though technical reports show Texas as one of the U.S. states with high solar potential, studies have to be conducted to determine the best location (i.e., direction and inclination) to ensure efficient electricity production. Indeed, several factors impact system efficiency, including the average hours of sunlight per year and the angle between the panels and the sunlight (SolarBuzz). The National Renewable Energy Laboratory (NREL) has developed maps (see Figure 3.32) to estimate the average potential energy production (in KWh/m^2/day) of solar panels by region. As can be seen, potential solar energy production increases from east to west Texas. Avoiding fixed and known obstructions and shadows—e.g., from buildings and trees—is important, however, as the NREL dataset does not account for these location-specific factors. The Oregon DOT (ODOT)—a pioneer in installing solar panels on ROW—points to the importance of a site's features, such as site terrain (i.e., how flat or level the site is) and existing infrastructure (e.g., fiber optic and wireless signal) to monitor and control production and ensure the integrity of the equipment.



Source: NREL (2010)

Figure 3.32: Potential PV Solar Panel Production in the U.S.

In addition, research and development have centered on improving solar cell efficiency and have achieved promising results in controlled environments (SECO, 2008). As solar energy technology evolves, more cost-effective solar panels will be developed. Finally, if solar panels can be incorporated early on in the design of new projects (i.e., roads and buildings), lower investment cost would be required. On the other hand, if solar energy systems are installed on existing buildings, the current electrical system has to be considered and analyzed as improvements would likely be needed.

3.6.2 Political/Public Concerns

Initiatives aimed at environmental protection and carbon footprint reduction typically receive attention and support from many organizations and politicians. Texas has enacted legislation to establish a renewable energy resource base and incorporate goals for renewable energy implementation (SECO, 2008). Hence, this VEA has some merit for TxDOT to improve the public perception of the agency. Furthermore, a number of federal and state bills have been passed to incentivize and facilitate the implementation of this renewable energy source. For example, the Executive Order 13514 issued by President Obama sets up "an integrated strategy toward sustainability in Federal Government and to make reduction of greenhouse gas emissions a priority of Federal agencies." Likewise, the FHWA is endorsing and promoting the incorporation of climate change considerations into the transportation decision-making process.

ODOT attempted to avoid or mitigate any public opposition to its solar projects beforehand. ODOT mentioned additional assessments and research the agency has conducted for a solar project near a residential area. As different concerns (e.g., concerns about electromagnetic field, glare, taxes, incentives paid, and property values) may arise, ODOT recommends conducting public involvement/outreach, visual impact analysis, and noise analysis. Moreover, ODOT cited the importance of a good relationship with the project neighborhood and argued that typically the majority of the issues stemmed from a lack of knowledge and awareness about the technology.

3.6.3 Legal Considerations

The Texas Legislature passed Senate Bill 20 (SB20) in 2005 to increase Texas's renewable energy goal (SECO, 2008). However, the major legal consideration for this VEA concerns the use of government incentives by a public agency (i.e., non-tax payer). The solution has been to enter into a public-private partnership (P3), where the private entity is the investor. Such a partnership was used by ODOT to ensure the feasibility of the first solar ROW project. Also the numerous subsidies, rebates, and tax credits have different nuances and legal considerations that have to be understood to prevent misinterpretations and wrong considerations. Tied with SB 20, for example, is the Renewable Portfolio Standard (RPS) that regulates and drives the Renewable Energy Credit (REC) market and the Solar Set-Aside program. Ultimately, the Net Metering Policy—which allows the renewable energy producer to sell back surplus energy produced to the grid at the retail price—could be important to the viability of a solar panel application. In Texas, the Net Metering Policy is not obligatory within the Electric Reliability Council of Texas (ERCOT) competitive area. Rather, it is a voluntary program in which the utility companies buy back the excess of production at a rate negotiated beforehand with the producer/consumer (SECO, 2008).

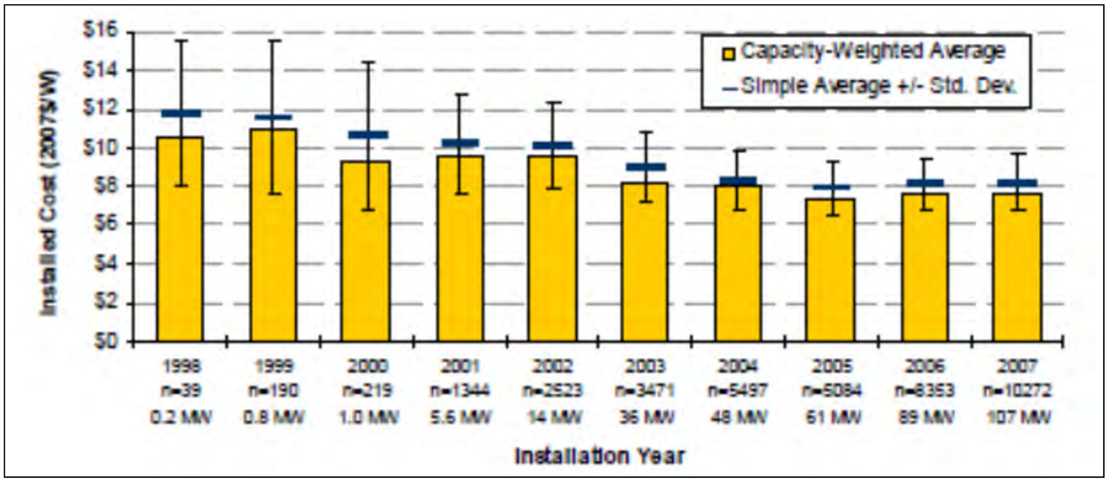
Another legal issue highlighted by ODOT and which most DOTs are not aware of is existing patents regarding the implementation of renewable energy sources along highway ROW. About 20 patents are held by Green Highway Company involving public land. Although ODOT has not been ignoring the existing patents, the agency commented on the possibility of challenging them and the need for a national action (i.e., FHWA, AASHTO, and the federal government) to overturn and decline them. Furthermore, ODOT cited that the FHWA regulations (e.g., airspace lease regulation, easement conditions, and accommodation permit) must be considered during the process and must be addressed in legal agreements (e.g., liability, responsibilities, access, maintenance, ownership over incentives and credits, land commitment, and shared risks). For example, ODOT mentioned the need for a long-term guarantee to use the land. The investor must be legally assured that the project can be removed only if a transportation need is clearly demonstrated. In addition, the DOT has to share risks with the investor to make the project financially feasible. The DOT must be liable for any damage to or theft of the panels. Also, the investor has to be indemnified from financial loss that is caused by external factors. The investor's responsibilities encompass construction and procurement of the project, maintenance of equipment and infrastructure, restoration, and preservation of the site. In fact, ODOT recommends the involvement of the State DOJ as well as legal counsel to advise and review the written agreements with private parties to minimize any potential risks and undesired liability for the DOT.

In addition, the Massachusetts DOT (MassDOT) pointed to the importance of verifying local zoning laws prior to moving forward with a project. MassDOT argues that most cities do not have revised zoning laws to address and regulate renewable projects. A lack of zoning law can defer or even impair the implementation of solar projects. Another issue is the proximity to public and military airports and likely interference or obstruction with air traffic, aircraft navigation/communication systems, and military radars. For any construction over 200 ft, the form "74601-Notice of Proposed Construction or Alteration" must be filed with the FAA prior to its outset. The FAA and the DOD will review the form and issue a permit. Typically, sites that are not within 3 to 5 miles of an airport are not deemed a hazard to air traffic (Volpe Center, 2011). Environmental analysis is also required for any renewable energy project on public land. Any project must be in compliance with NEPA—either the FHWA or DOE process, if not both—to receive an environmental permit. Ultimately, the FHWA has to review all documents (e.g., permits, drawings, analysis of impacts, and contractual agreements) from any project located in highway ROW before it can issue a final permit, allowing the project to move forward.

As has been noted in previous sections of this report any placement of such structures on or adjacent to the ROW (federal and state) will also have to comply with the provisions of CFR, TC, and TAC and not compromise mobility, safety, and the ability of TxDOT to control its assets in the best interests of the general public. Furthermore, investors will have to be charged at not less than fair market value. Finally, the placement of any such solar panel technology adjacent to the ROW will need to comply with the rules regarding highway beautification. TxDOT would also need to ensure that no stray light or light movement from the solar panels was visible to oncoming motorists.

3.6.4 Financial/Economic Feasibility

The cost of solar energy technology is arguably the major obstacle to the widespread application of solar panels (see Figure 3.33). However, several incentives and subsidies, such as rebates and tax credits, are available for this application. The most significant incentives are typically granted by federal and state governments (DSIRE). ODOT, for example, was granted \$2 million for its first project that was awarded to its partner (i.e., investor). These incentives, however, vary from year to year. Furthermore, "innovative financing mechanisms using public-private-partnerships" (P3s) allow DOTs to "secure clean renewable energy—without paying a premium—from assets it already owns" (ODOT). These P3s can "utilize state energy tax credits, federal incentives, and utility incentives to finance solar projects, which the DOT—having no tax liability—cannot take advantage of on its own" (ODOT 2010).



Source: Wiser et al. (2009)

Figure 3.33: Installed Cost of Solar Project from 1998 to 2007

Another financial consideration is the payback period for the investment (SolarBuzz). In fact, the cost of large-scale solar energy production is quite high compared to other energy sources (SECO, 2008). Hence, incentive programs reduce the payback period and largely drive and determine the feasibility of solar projects (SolarBuzz).

The highest cost component is the equipment itself—representing 40–50% of total installed cost (SolarBuzz). Because the technology is evolving and the demand has been increasing, there is an expectation that the overall cost of solar systems and, consequently, the need for incentives will reduce in future (SECO, 2008). Indeed, installed costs have declined over the years (see Figure 3.33). From 2005 to 2007, installed cost has, however, remained largely unchanged. The latter has been attributed to solar panel demand, which created a shortage in the supply, and consequently, resulted in higher module prices (Wiser et al., 2009). Furthermore, unlike the module prices that are dictated by the national market, the remaining 50–60% of total installed costs are associated with non-module components and, hence, are driven by local programs (Wiser et al., 2009).

Although the maintenance cost of solar panels is important to life-cycle cost analysis, it does not represent a significant cost relative to the initial cost (e.g., installation and site preparation) and is typically expected to represent 1% of the initial hardware investment annually—i.e., equipment (PVResources, 2010). Also, solar panel maintenance is typically the responsibility of the utility agency, as is any damage due to vandalism or incidents that may occur. ODOT mentioned, on the other hand, that it was crucial to share risks (e.g., vandalism and incidents) with the utility company to ensure the financial feasibility of their first project. In addition, the majority of solar panel vendors provide a 25-year warranty on the equipment; therefore, this period should be used in the life-cycle cost analysis. ODOT commented that the maintenance of its pioneer solar project has been minimal. Thus far, the vendor has changed some cracked panels—without cost to the investor (i.e., warranty coverage). Plus, mowing activities have been performed a couple of times during the summer. Finally, cleaning and washing the panels have not been needed. The rain has been enough to keep the panels clean (Volpe Center, 2011). On the other hand, two additional factors that may impact the feasibility of the solar systems are interest rates and on-grid electricity price growth. These factors are difficult to predict and have to be carefully considered.

If the solar panels are connected to local system grids, potential revenues can be explored. Some electricity providers offer consumers/producers credits for excess electricity produced by the solar system that is fed into the utility grid (SECO Website), i.e., net metering. In fact, ODOT also cites the grid connection as the most cost-effective way to implement solar projects and because of that ODOT recommends sites that are a maximum half-mile away from transmission lines.

Solar panel owners can also benefit from selling RECs generated by their system. This additional income can be added to other incentives granted by utility, state, and federal programs. The potential revenue generated is determined by the type of REC market that exists where the solar energy system is located. A voluntary REC market is characterized by the voluntary nature of the transactions (Wiser et al., 2009). In Texas, "the RPS provides for a REC trading program that will continue through 2019" (SECO Website). A REC market promotes greater flexibility and provides an incentive for companies to pursue renewable energy projects because electricity suppliers can resort to the market to meet renewable energy capacity targets without investing in the new technologies—hence, providing opportunities for trades (SECO). In Texas, the RECs are issued quarterly, based on meter readings. The Texas electric grid operator, ERCOT, is entitled to monitor and control the REC market. Furthermore, the Public Utility Commission of Texas (PUCT) can cap the price of RECs or even suspend the RPS if it is regarded as necessary to maintain the reliability and operation of the grid system (SECO). In Oregon, ODOT mentioned that the RECs were fundamental to the success and viability of the pioneer project. ODOT also argued that in future projects the agency will benefit from a portion of the RECs, as opposed to the pioneer project in which all the RECs go to the investor (i.e., private partner).

As mentioned, typically in a solar project the DOT will enter into an agreement/partnership with a utility company and/or private investor. Different business models can be used according to the DOT's goal and the interest of the investor. It is important to bear in mind that the attractiveness and financial feasibility of the project may vary depending on the business model adopted. Following are the four business models generally used for solar projects:

- The DOT purchases all the renewable energy generated from the project. This model was used by Oregon DOT in its first pilot project;
- The DOT charges a rent fee—following the airspace leasing policy—and does not purchase any renewable energy or acquire any RECs. This model is being proposed by Caltrans and Massachusetts DOT;
- The DOT acquires only the RECs from the project and the investor sells the electricity generated as non-renewable;
- The DOT owns and operates the entire solar system. This model is generally used for DOT facilities (i.e., offices, rest areas, and maintenance facilities). In the case of highway ROW, the Ohio DOT explored this model in its first project, but later realized and asserted that owning and operating solar systems is not a sustainable business model for ROW projects as long as the cost of renewable energy is still high (as DOTs cannot benefit from incentives).

In a remote residential market or industrial application, solar panels can be a less expensive alternative than diesel power or another energy source that requires long transmission lines. Whether required or not, transmission and distribution investments are important factors that have to be considered when analyzing the financial feasibility of solar panels. Disregarding these investments can underestimate and ignore the potential benefits from solar systems (Borenstein, 2008). Most discussions of the real value of solar panels in fact revolve around the savings that can be derived from reduced transmission and distribution infrastructure investments (Borenstein, 2008).

Finally, it is important to highlight that these financial assessments typically ignore the social benefits of environmental preservation, carbon credits, and increased security, as well as other social benefits.

3.6.5 Environmental Considerations

Solar power is environmentally friendly, does not produce emissions, and is non-polluting. Therefore, solar power generation does not contribute to noise, air, or effluent pollution as well as the carbon footprint or waste disposal. Moreover, photovoltaic panels do not need and use water for electricity generation. Solar panels furthermore contribute to reduced water consumption as solar energy offsets the likely energy production from conventional energy sources, which require water to generate power (SECO, 2008). Water is a precious natural resource and has been the subject of many discussions among environmental and political groups. Given the worldwide preservation and conservation of water using an energy source that does not require water is beneficial.

Despite the environmental benefits of solar panels, some concerns have emerged regarding the disposal of these panels at the end of their life (SECO, 2008). Photovoltaic technology uses heavy metals such as cadmium, and improper panel disposal could harm the environment. Moreover, whenever batteries are integrated with the solar system considerations regarding battery disposal and recycling must also be taken into account and addressed. Some solar manufacturers have, however, developed or implemented recycling programs and reprocessing techniques, which can overcome disposal concerns (SECO, 2008).

3.6.6 Potential Social Impacts/Benefits

The solar industry could create more than an estimated 100,000 new jobs in areas such as technology research and development (R&D), manufacturing, and electrical services (The UT, 2007). In general, researchers have found that renewable energy generates more jobs in the construction and manufacturing sectors per megawatt installed, than fossil fuel (SECO, 2008). To ensure that all aforementioned social benefits will be attained and maximized for local communities, ODOT came up with “value based investment in renewable resource development” criteria in lieu of the common procurement practice of lowest cost. ODOT believes that “adopting value-based selection criteria will change the focus of public investments from cost to return on investment.” The value-based procurement criteria include

- use of local manufacturers,
- long-term warranties,
- world-class sustainable manufacturing practices,
- direct and sustained local employment and training,

- reinvestment in innovative technology and partnership with local universities,
- guaranteed end-of-useful life product recycling, and
- training of small local businesses in product installation.

Following these criteria, ODOT can secure social, environmental, and financial (i.e., higher return on investment) benefits.

Perhaps the most important social benefit of solar panels is the system's ability to furnish electricity to remote areas where the cost of building transmission lines could be prohibitive. Electricity is fundamental to societal welfare, quality of life, and economic development and it has been argued that solar panels can generate electricity without disturbing and impacting the community. A solar energy program can create public involvement, increase environmental awareness, and provide an opportunity to educate the public about the importance of reducing the carbon footprint.

3.6.7 Safety Considerations

Solar panels do not pose any risks in terms of explosions, fire, disasters, structural failures, or accidents inherent to most of the other energy sources. The installation of solar panels has, however, raised some safety concerns regarding glint and glare (i.e., light reflectiveness), the clear zone, and protecting solar panels from cars and people (e.g., incidents and vandalism). These concerns can be easily overcome if the implementation of the solar panels is considered and incorporated in the design of new projects. On existing roads, unused terrain near exit ramps is seen as an ideal location to overcome safety problems. Guard rails can also be used as an alternative to minimize and mitigate safety concerns. ODOT reinforced the importance of safety zones and established that 30 feet from the road's shoulders is the minimal set-back for solar panel projects; other DOTs have adopted different minimal set-back requirements. Furthermore, ODOT remarked on the need to access the panels as a safety concern in the pioneer project. Vehicles and trucks operating at slow speeds or maneuvering on the highway poses a risk to other drivers. To overcome this concern, ODOT mentioned the need for alternative access roads besides the major highways (e.g., interstate). For example, for the pioneer solar project ODOT required a traffic control plan to be submitted to the District office prior to the granting of the Utility Permit. The FHWA also has to review the project characteristics and follow the utility permit process before a permit can be issued. Furthermore, in the specific case of glint and glare issues, a report issued by FAA in November 2010, entitled "Technical Guidance for Evaluating Selected Solar Technologies on Airports" notes that solar panels are designed to absorb and use sunlight. Observations from pilot projects indicate that no glint or glare issues have been noticed, reported, and presented on solar projects in highway ROW (Volpe Center, 2011).

3.6.8 Examples

ODOT is the pioneer in implementing solar panels in highway ROW. In December 2008, ODOT concluded the installation of the first solar arrays project at the interchange of IH 5 (see Figure 3.34). The arrays—consisting of 594 panels, ground-mounted—can produce up to 130 KWh annually, i.e., one-third of the energy needed on the site. The solar arrays feed the grid with the electricity produced during the day whereas at night the grid supplies the electricity for interchange lighting at the site. According to ODOT, the project location was carefully selected and represented a major objective in the ODOT's initiative toward renewable energy and sustainable development. During the project site selection, ODOT developed a list of "Solar Highway Project Siting General Criteria" as follows:

1. at least 5 acres and less than 20 acres if within rural zoning,
2. full access from a paved or gravel roadway to the array,
3. utility and road access available for at least 35 years,
4. within one-half mile of existing electricity grid,
5. fiber optic connectivity for security and research data transmission,
6. terrain slope less than 15%, and
7. total solar resource fraction of at least 95% to be economical.

Source: ODOT (2009)

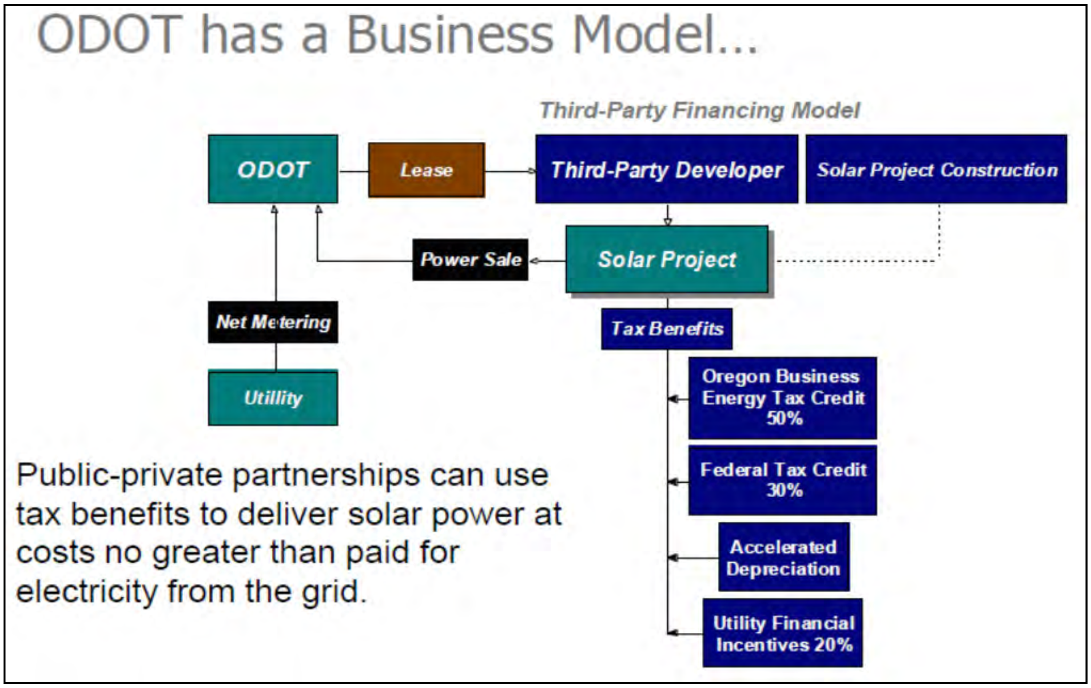
Figure 3.34: Oregon Solar Array Project

Moreover, if the site is in ROW, a 30-foot clear zone from the edge of the travel lane shoulders was established for safety reasons. ODOT pointed to highway interchanges as sites that will likely meet all the previous criteria. In addition, ODOT believes that the most cost-effective solar project involves a public utility or private investor as partner and for the system to be connected to the grid, so both net metering and the RECs apply. To do so, ODOT developed an innovative business organization model (see Figure 3.35) that could best meet the project characteristics and needs. By adopting this business model, ODOT was able to incorporate all tax benefits (i.e., incentives and accelerated depreciation) and RECs with the project—thereby making the project financially feasible. Initially, ODOT partnered with Portland General Electric (PGE), a local utility company, to develop the solar project. However, because neither ODOT nor PGE could take advantage of the federal and state incentives (they do not have tax liability), U.S. Bank was brought in as a tax equity investor (i.e., third-party developer). In other words, U.S. Bank owns the solar project and leases the project to PGE, which is liable for the maintenance, operation, and security of the solar system. This allowed U.S. Bank to claim the following tax benefits:

- State's Business Energy Tax Credit (BETC), which covered 50% of eligible cost (i.e., permit fees, equipment, engineering, design, materials, and installation);
- 30% of Federal Investment Tax Credit, granted by the Energy Policy Act of 2005 (EPACT) and extended by the American Recovery and Reinvestment Act of 2009 (ARRA);

- utility financial incentives; and
- accelerated depreciation.

Figure 3.35 clearly shows all the parties involved and how the incentives were obtained by the developer.



Source: ODOT (2009)

Figure 3.35: ODOT Business Model for Solar Array Project

ODOT estimated that installing solar arrays on 120 miles of ROW could supply about 47 million KWh of energy—equivalent to the annual energy consumption by ODOT. Regarding the lessons learned, ODOT pointed out the requirements for safety (e.g., clear zone, reflectivity, alternative site access, and traffic control), grid interconnection, avoiding shading, and security. Also, ODOT mentioned the need for an internal champion, leadership and management support, and commitment over time. However, ODOT asserted that solar resource development still requires incentives (e.g., tax credits) and other financial support from federal and state governments to be financially feasible. For example, ODOT's project received $2 million in federal stimulus funding. Moreover, the carbon offset (i.e., REC) created by the solar energy project was valued at $30 per metric ton by the developers (i.e., PGE).

Besides the technical and financial factors previously mentioned and discussed, ODOT highlighted the importance of public outreach to educate the public on renewable energy technology and to effectively address any concerns raised by the public (Volpe Center, 2011). Finally, ODOT and its partner are planning to implement a new 1.7 megawatt (MW) solar project on a 6.4 acre site adjacent to the Baldock Rest Area on IH 5. A third project is also under development—a 3MW solar panel system—on a terraced hillside near IH 205 at the ODOT maintenance facility in West Linn (Volpe Center, 2011).

In California, Caltrans is partnering with the Sacramento Municipality Utility District (SMUD) to explore two 594-panel (1.4MW) projects, using photovoltaic and concentrator PV systems simultaneously. The two sites chosen are along IH 50 and are currently under environmental review. The following siting criteria were used to select the site:

- southern exposure to maximize generation potential;
- independent access to the site from an entry point other than the road itself;
- compliance with Caltrans's safety requirements (i.e., height and ~50ft of setback);
- close proximity to SMUD electrical facility to minimize transmission line costs;
- size of the parcel to ensure financial feasibility and interest of private developer; and
- any competing commercial or private demand for the land (i.e., developers' interest).

Unlike the ODOT model, SMUD will enter into an agreement with a developer to design, construct, operate, and maintain the solar system. SMUD will then purchase the renewable energy generated from the developer and resell it to its utility customers through its Solar Shares program. SMUD will pay Caltrans a fixed rent for using Caltrans's ROW. Public outreach was also an important step in the project. SMUD held four public workshops in September 2010 and developed visualizations (e.g., conceptual drawings, realistic photos, and 3D animation) to help explain the project (i.e., characteristics and objectives) to the public. Currently, Caltrans is analyzing the feasibility of installing solar charge stations for electrical vehicles along highways, as well as the installation of solar panels for light poles (Volpe Center, 2011).

The Colorado DOT (CDOT) and Ohio DOT have worked with local consulting companies and/or universities to identify opportunity zones and sites suitable for renewable energy projects in highway ROW. The identification has been made by overlaying ROW maps and geographic information system (GIS) data layers of renewable energy source potential (i.e., solar, wind, geothermal, and biomass resource maps). Currently, Ohio is exploring various renewable energy projects in their highway ROW and on other real estate holdings (Volpe Center, 2011). For example, in 2010 the Ohio DOT, in conjunction with the University of Toledo, installed a 100KW solar array—composed of 966 rigid solar panels (see Figure 3.36) and 198 flexible solar panels (see Figure 3.37)—in the ROW of IH 280 and Greenbelt Parkway in Toledo, OH. The solar array supply all the electricity needed for the Veteran's Glass City Skyway Bridge, which has a 196-foot lighted pylon containing 384 light emitting diode fixtures (Volpe Center, 2011).

Source: Volpe Center (2011)

Figure 3.36: Rigid Solar panels installed along IH 280 in Toledo, OH

Source: Volpe Center (2011)

Figure 3.37: Flexible Solar Panels installed along IH 280 in Toledo, OH

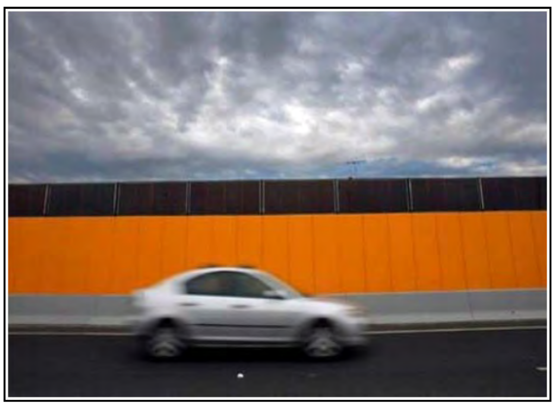
MassDOT is working with the Town of Carver, Massachusetts, to allow the implementation of a solar array project with a 117 KW installed capacity along Route 44. MassDOT will concede an easement to the Town of Carver, granting full access to the site, and the Town will be responsible for partnering with a developer to install, own, and operate the solar array. The Town will then purchase the renewable energy from the vendor to provide electricity to its new water treatment facility. MassDOT will receive $880 per year from the Town as payment for the land used. This value was reached after the Town got an appraisal of the value of the land. The site selected has an embankment at a 36° angle, which makes it well suited for a solar array. The solar array will be set back 65 feet from the highway with direct access through the water treatment facility. However, as a condition to the easement the Town or developer will have to install guardrail on the roadside along the entire extension of the solar array. The easement also contains a clause regarding potential future relocation of the solar system. If MassDOT needs the area for future road lane expansion, the Town and developer will be required to remove the system without charging MassDOT (Volper Center, 2011). Furthermore, like CDOT and Ohio DOT, MassDOT has been working with a consulting firm to assess its real estate holdings and identify potential sites for large and small wind and solar projects. The consulting firm has overlaid GIS data of MassDOT's real estate holdings and National renewable resource data. MassDOT has adopted with a set of criteria to assess the feasibility and suitability of potential sites. The criteria include minimal site acreage, minimal set-back, access, proximity to utility connections, environmental issues, and proximity to residential areas and other developments (Volpe Center, 2011).

A number of solar projects can be found in European transportation ROW. Germany, for example, has invested €11 million in a solar panel project on top of a tunnel on highway A3 that has a 2.8 MW capacity (Figure 3.38). The investment cost is expected to be recovered in 16 years from cost savings. The 16,000 solar modules occupy 2.7 km and will provide electricity to nearly 600 houses (PV-tech.org, 2009).

Source: ODOT (2009)

Figure 3.38: Solar Array in Germany

In the United Kingdom (UK), Netherlands, Switzerland, Austria, France, and Germany, as well as in Australia, solar panels have a "dual use." Besides energy generation, the panels also act as sound barriers (see Figures 3.39 and 3.40).



Source: Chapa (2008)

Figure 3.39: Solar Panels as Sound Barriers in Australia

Source: www.photovoltaik.eu/ (2010)

Figure 3.40: Solar PV as Sound Barriers in UK

Finally, solar panels can also be installed on buildings such as offices, rest areas, and warehouses. The concept of green rest areas has been widely supported by the DOTs in Connecticut, Massachusetts, Colorado, and Wyoming. Specifically, the Wyoming DOT (WDOT) has 19 rest areas that use solar power to provide an estimated half of the rest areas' energy needs. To bring more attention and curiosity about renewable energy and GHG emission reduction, WDOT installed solar "flowers" at a rest area on IH 70 near Parachute in August 2010 (see Figures 3.41 and 3.42). In this case, the solar panels also have an aesthetic function and educational purpose. In Texas, solar panels will be installed at two new rest areas along IH 20.

Source: Garfield Clean Energy (2010)

Figure 3.41: Solar Flower in Wyoming Rest Area

Source: Garfield Clean Energy (2010)

Figure 3.42: Solar Flower in Wyoming Rest Area

3.6.9 Concluding Remarks

Solar energy technology is evolving. In general, the main barrier to the implementation of solar panels is the price and consequently, long payback period. Several federal and state government incentives have helped the adoption and construction of solar energy projects. In the case of solar panels in highway ROW, the following points have to be considered:

a. the site location and characteristics (e.g., area, terrain, alternative access, clear zone, avoiding shade, existing zoning laws, aesthetics, and sunlight intensity);
b. the business model (e.g., P3), net-metering policy, and the RECs;
c. in remote areas, solar panels can overcome or reduce the need for transmission lines;
d. in urban areas, the distance to transmission lines is an important factor in the feasibility of the project;
e. contractual agreements stipulating liabilities, risks, and responsibilities (e.g., site security, maintenance, termination conditions, and ownership of the REC) are important. The involvement of the State DOJ, as well as legal counsel, is always recommended to advise and review the written agreements with private parties to minimize any potential risks and undesired liability to the DOT;
f. permit requirements (utility accommodation, airspace lease, special use permits, easements and FAA permits) have to be clearly understood;
g. potential issues concerning Texas's Highway Beautification Act and Wildflower program may emerge as a renewable energy source, solar panels can be used to reduce the carbon footprint and the dependence on fossil fuels, and enhance sustainability goals;
h. issues may arise when installing solar panels close to communities, due to a lack of knowledge and awareness about solar technology;
i. upper-management support and an in-house champion, who would be responsible for leading and managing the entire implementation process is considered important;

j. effective public involvement and support are needed; and
k. compliance with NEPA and other environmental regulations are essential.

3.7 Wind Turbine

Wind energy has been developed rapidly in the U.S. and new types and models of wind turbines have been studied extensively. For example, new designs have been developed to generate electricity from the air turbulence associated with traffic flow. However, the viability of the latter models has not been proven yet.

3.7.1 Technical Feasibility

Different sizes of wind turbines have different electricity generation capacities. The wind speed (which changes with the altitude) is, however, the major factor that determines the performance and viability of each type of wind turbine (Chapman et al., 2009). Hence, the selected wind turbine type is thus determined by the characteristics of the location of installation as it directly determines capacity and efficiency. Another factor to consider is the available land area for the installation and minimal distance required between two adjacent wind turbines. Relative to other renewable energy sources, wind turbines require a larger area by KWh of electricity generated, but generally less than solar photovoltaic panels. However, new turbine models—called small wind turbines (see Figures 3.43 and 3.44)—have facilitated the production of wind energy in smaller areas.

Source: DOE (2005)

Figure 3.43: Small Wind Turbine Model

Source: DOE (2005)

Figure 3.44: Small Wind Turbine Model

Unlike solar panels, wind turbines can generate electricity any time of the day, although they are more efficient at night. Nevertheless, a wind energy system cannot be fully independent and reliable. To ensure electricity throughout the day, it is essential that the wind energy system be connected to the grid or backed up by batteries. A hybrid system that consists of a wind and solar system could be an alternative option as solar and wind peak productions occur at different times of the day. The hybrid system can have backup batteries also. The advantage of a hybrid system is that it can provide reliable off-grid energy—hence, saving on transmission line costs.

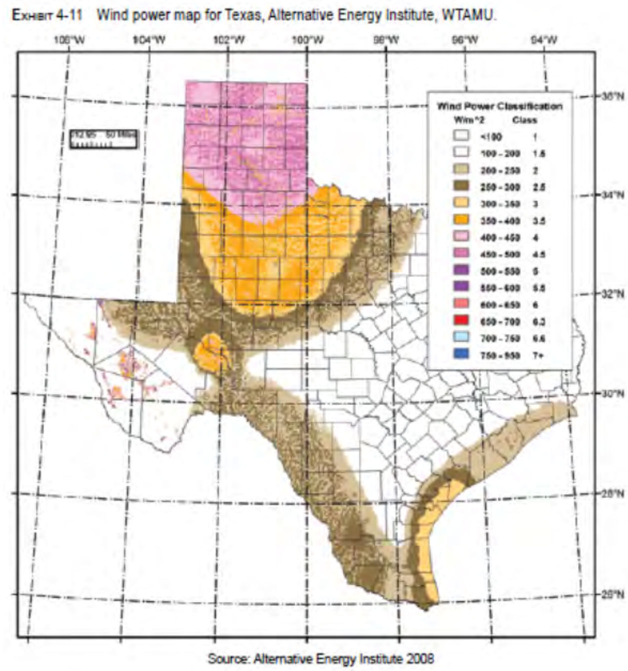
Source: DOE (2005)

Figure 3.45: Wind Turbines near a Highway

Important factors to consider when installing wind turbines are the construction plan, transportation requirements, and impacts on existing roads/traffic. (Figure 3.45 depicts wind turbines near a highway.) All analysis has to be done prior to deciding whether to move forward with the project. Furthermore, the wind system must comply with local electrical code requirements or, at least, with the National Electrical Code (NEC) published by the Fire Protection Association (DOE, 2005). Vendors therefore have to provide proof of certification prior to finalizing the agreement.

Wind turbines require more maintenance and supervision than solar energy systems. However, by investing in good equipment and starting with good design and proper installation, these disadvantages can be overcome (Homepower Magazine).

Figure 3.46 shows the estimated annual production capacity per m^2 of wind turbines in Texas. Texas has the best wind power generation potential in the U.S, specifically north and south Texas, as well as the coastal zones (SECO, 2008).



Source: SECO (2008)

Figure 3.46: Wind Power Potential in Texas

Novel models of small wind turbines that rely on the air turbulence generated by passing traffic are still largely in the development phase. The efficiency of these systems is largely a function of the traffic density. Moreover, over-the-highway turbines have to allow trucks to pass under them. Also, the turbulence associated with cars may be insufficient for generating energy.

3.7.2 Political/Public Concerns

Research has shown that wind turbines can negatively affect nearby communities and lands. Concerns have been expressed about "visual aesthetics, tourism, property value, public roads, public safety, and quality of life for people living close or at a distance from the developments" (Tillinghast, 2004). In England, for example, a British judge ruled that the wind turbines 0.35 miles away reduced property values by 20% due to noise, visual intrusion, and flickering of light (Tillinghast, 2004). Another study in Denmark also found that windmills decrease housing prices. In the U.S, realtors also believe that windmills impose a negative impact on nearby properties, although the impact on the price cannot be estimated. For the Cape Wind project in Massachusetts, for example, the impact on property values is estimated to range from 4.0% to 10.9% (Tillinghast, 2004). Because wind turbine installation can impact private properties, it is important to conduct public outreach prior to developing wind projects (SECO, 2008) on TxDOT sites. On the other hand, implementing a renewable energy source, such as wind turbines, at rest areas or weigh stations can be highly visible to the travelers and general public. This approach provides an opportunity to demonstrate environmental responsibility and gain political support (Chapman et al., 2009). Furthermore, mid- and utility-scale wind turbines, as well as site characteristics and location, can significantly reduce the impacts of wind mills, thereby minimizing and/or mitigating any likely public opposition and concerns.

3.7.3 Legal Considerations

The major legal consideration for this VEA concerns the use of government incentives by a public agency (i.e., non-tax payer). The solution has been to enter into a public-private partnership (P3), where the private entity is the investor. Such a partnership (i.e., a P3) was used by ODOT to ensure the financial feasibility of the first solar ROW project. Also the numerous subsidies, rebates, and tax credits have different nuances and legal considerations that have to be understood to prevent misinterpretations and wrong considerations. In Texas, for example, the Net Metering Policy—which allows the renewable energy producer to sell back surplus energy produced to the grid at the retail price—is not obligatory within the Electric Reliability Council of Texas (ERCOT) competitive area. Rather it is a voluntary program in which the utility companies buy back the excess of production at a rate negotiated beforehand with the producer/consumer (SECO, 2008).

Another legal issue highlighted by ODOT and which most DOTs are not aware of is existing patents regarding the implementation of renewable energy sources along highway ROW. There are about 20 patents held by Green Highway Company that involve public land. Although ODOT has not been ignoring the existing patents, the agency commented on the possibility of challenging them and the need for national action (i.e., the FHWA, AASHTO, and the federal government) to overturn and decline them. Furthermore, ODOT cited the FHWA regulations (e.g., airspace lease regulation, easement conditions, and accommodation permit) that needed to be considered during the process and legal agreements (e.g., liability, responsibilities, access, maintenance, ownership over incentives and credits, land commitment, and shared risks) that must be negotiated.

The height of some wind turbines may also raise concerns. Some jurisdictions impose a limit on the height of the structures in residential areas because of view obstruction. Other concerns that wind turbines may provoke in residential areas involve noise, shadow, and light reflection. In airport zones (i.e., military or public airports), there are also height thresholds that must be addressed (DOE, 2005). Indeed, for any construction over 200 ft, the form "74601-Notice of Proposed Construction or Alteration" must be filed with the FAA prior to its outset. The FAA and the DOD will review the form and issue a permit. Typically, sites that are not within 3–5 miles of an airport are not deemed a hazard to air traffic (Volpe Center, 2011).

Massachusetts DOT (MassDOT), for example, also pointed to the importance of verifying local zoning laws prior to moving forward with the project. MassDOT noted that most cities do not have revised zoning laws to address and regulate renewable energy projects. A lack of zoning law can defer or even impair the implementation of wind projects. Environmental analysis is also a requirement for any renewable energy project on public land. A project must comply with NEPA—either the FHWA or DOE's process, if not both—to receive an environmental permit. Ultimately, the FHWA has to review all documents (e.g., permits, drawings, analysis of impacts, and contractual agreements) from the project—if located in highway ROW—to issue a final permit and to allow the project to move forward.

If wind turbines are placed in the ROW through a lease agreement, the provisions of Texas Administrative Code (TAC) Title 43, Chapter 21 ROW would set the rules. Within Sub-chapter L—leasing of highway assets—under Rule 21.602 the Commission can authorize the lease of a highway asset if the interest to be leased is not needed for a highway purpose during the life of the lease, and the use of the property will be consistent (and not impede) with safety, maintenance, operation, and beautification of the system. The lease must also be economically beneficial to TxDOT.

Under TAC Rule 21.605 the use of leased ROW beneath the established gradeline of the highway shall provide sufficient vertical and horizontal clearances for the construction, operation, maintenance, ventilation, and safety of highway facilities (Rule 21.605 (b)). The use of leased highway ROW above the established gradeline of the highway shall provide for vertical and horizontal clearances (Rule 21.605(c)). Piers, columns, or any other portion of any improvements to be constructed on the leased ROW cannot be erected in a location that will interfere with visibility (or reduce the sight distance) *or in any other way i*nterfere with the safety and free flow of traffic or level of service on highway facilities. Structural supports for any improvements must be located clear of all horizontal/vertical dimensions specified by TxDOT (Rule 21.605 (e)). All these restrictions and the use of the ROW shall not result in highway and non-highway users being unduly exposed to hazardous conditions (Rule 21.605 (f)). This includes a requirement in Rule 21.605 (g) for appropriate safety precautions and features *necessary* to minimize the possibility of injury to users of the highway or the leased facility be provided. TxDOT will determine the acceptability of these features considering the adequacy for evacuation of structures in case of a major accident.

As has been noted in previous sections of this report, any placement of such structures on or adjacent to the ROW (federal and state) will also have to comply with the provisions of U.S. CFR, TC, and TAC. These structures cannot compromise mobility, safety, and the ability of the DOT to control its assets in the interest of the general public and will need to be charged no less than fair market value for the use of the DOT's assets.

Finally the placement of any such wind turbines within or adjacent to the ROW will need to comply with the rules regarding highway beautification. For example, TXDOT would need to ensure that no stray light or overt movement from the moving wind blades is visible to oncoming motorists.

3.7.4 Financial/Economic Feasibility

Wind turbines demand a considerable initial investment, but can be competitive to conventional energy sources (DOE, 2005). Relative to other renewable energy sources, wind turbines also have comparatively higher upfront costs, but the turbines are generally more efficient (i.e., in terms of cost per KWh produced). Moreover, the cost-effectiveness of wind turbines, in general, improves as the size of the rotor increases. For example, it has been estimated that a small wind system can lower an electricity bill by 50% to 90% (DOE, 2005). Nevertheless, wind energy development is still driven by incentives, subsidies, and tax credits. Similar to solar panels, transmission lines can determine the economic viability of the system. For example, if the wind turbines are installed near the end-user, considerable costs can be saved in terms of reduced transmission costs, enhancing the financial feasibility of wind (SECO, 2008).

To measure economic feasibility and compare alternative electricity generating options, the concept of levelized cost of energy (LCOE) is used. The LCOE is the average cost of the energy produced by a particular energy system over a specified time period. For wind energy, LCOE includes the cost of the turbine, the operation and maintenance expenses, the interest rate (cost of money), inflation, cost growth of grid-based electricity, permitting and zoning cost, and the life of the equipment—generally estimated as 25 years (Chapman and Wiczkowski, 2009). The main factors, however, are the installed cost and the annual net energy production (SECO, 2008). The installed cost is a function of commodities' prices, including steel, copper, and cement, as these are the main materials that wind turbines are made of or that are needed for installation.

Another consideration is whether the system will be tied to the grid. Off-grid wind systems are battery based, which is usually expensive and demands intensive maintenance. The cost of maintaining the batteries must be offset by the cost saving of building transmission lines to connect the wind system to the existing grid. Battery-based systems are usually more feasible in very remote areas or where it is difficult to connect the renewable energy source to the grid (Homepower Magazine Website). For on-grid systems, "net metering" is essential to ensure the economic feasibility of the wind project and to decrease the payback period. Net metering allows the renewable energy producer to sell any surplus electricity generated—and returned to the grid—to the utility company (DOE, 2005). Although federal regulations obligate utility companies to connect with and buy net electricity from small wind turbines, the utility should always be contacted prior to tying the wind system to the grid (DOE, 2005).

Finally, similar to solar panels, wind turbine owners can benefit from the REC market and set-aside program. Also, carbon dioxide trading could enhance the feasibility of both solar and wind energy systems. Once it becomes environmental policy in the U.S., these non-carbon emission energy sources will become even more valuable (SECO, 2008).

As previously noted, typically with wind turbine projects the DOT will enter into an agreement/partnership with a utility company and/or private investor. Different business models can be used given the DOT's goal and the interest of the investor. Note that the attractiveness and financial feasibility of the project may vary depending on the business model adopted. Following are the four business models generally used for wind projects:

- The DOT purchases all the renewable energy generated from the project. This model was used by Oregon DOT in its first solar pilot project;
- The DOT charges a rent fee for the land asset used—following the airspace lease policy—and does not purchase any renewable energy or acquire any RECs. This model is being used by Caltrans and Massachusetts DOT;
- The DOT acquires only the RECs from the project and the investor sells the electricity generated as non-renewable;
- The DOT owns and operates the entire wind system. This model is generally used for DOT facilities (i.e., offices, rest areas, and maintenance facilities). In the case of highway ROW, Ohio DOT adopted this model in its first renewable energy project, but afterward realized and asserted that owning and operating a wind system is not a sustainable business model for ROW projects, while the cost of such a system is still high. DOTs cannot benefit from certain tax incentives and thus the system's cost is prohibitive for DOTs.

3.7.5 Environmental Considerations

Similar to other renewable energy sources, wind energy is environmentally friendly as it reduces the carbon footprint by producing clean energy without emitting CO_2, NO_X, and SO_X. Similar to solar panels, it also does not require water for generating electricity (SECO, 2008). Furthermore, by installing wind turbines in the highway ROW, drivers can be made aware of the importance of renewable energy as an alternative energy source. However, most wind turbines represent a hazard to birds and bats. In Kansas City, a new type of turbine was installed on IH 435 that overcomes this problem. The design of this wind turbine was developed by A. L. Huber Construction and can be found near the intersection of IH 435 and Roe Avenue (see Figure 3.47). Although this model does not resemble a traditional wind mill, it has the most advanced wind technology and is capable of generating 5,000 watts of power (KMBC, 2009). Moreover, this wind turbine model needs only 6 mph of wind to produce energy. Major benefits include decreased or avoided bird kill, noise generation, and ice throw, which are common disadvantages of traditional wind turbines (KMBC, 2009).

Source: KMBC (2009)

Figure 3.47: Kansas City Model

Another environmental problem concerns the likelihood of oil leaking or a turbine's motor catching fire. Oil leaks can contaminate the soil as can the detergent generally used to clean the turbine. Fire (see Figure 3.48) always poses a danger to the environment, especially if it is not controlled early and easily extinguished. Other environmental concerns entail noise and visual impacts. While the noise from blades and gearboxes has been reduced with newer models of wind turbines, the visual impacts imposed are sensitive to the location of the wind turbine. For example, rural and tourist areas are more sensitive about visual impacts than urban areas (SECO, 2008). Finally, in the case of both solar and wind energy systems, the stand-alone off-grid systems impose environmental concerns because of the batteries. Battery maintenance requires precautions and plans to avoid site contamination, and battery usage and disposal are potentially damaging to the environment. If batteries are used, a disposal plan needs to be developed and implemented. Wind energy systems connected to the grid are thus usually the most cost-effective and environmentally friendly option (Homepower Magazine, 2010).

Source: Hoffman (2010)

Figure 3.48: Fire on Wind Turbine Rotor

3.7.6 Potential Social Impacts/Benefits

Wind energy systems can potentially provide electricity to remote areas, thus benefiting distant communities. Also, by installing a renewable energy source, DOTs can make a statement and educate the public about green energy and the importance of reducing the carbon footprint. The installation and maintenance of wind turbines (i.e., aside from the equipment manufacturing and operation) require a trained workforce that can benefit rural economic development (SECO, 2008). On the other hand, wind turbines cause noise and shadows, and reflect sunlight. Those that live near wind farms have complained about these impacts. Also, the literature revealed that wind turbines near television antennas, telecommunication towers, or radar can cause interference with the signals, thus directly impacting the quality of life of those who live nearby (Tillinghast, 2004).

As previously mentioned, wind turbines can potentially decrease nearby property values and consequently property tax payments. Cities impacted by wind turbine developments could thus be obligated to raise taxes to recover the revenue lost. Property owners outside the wind turbine impact zone could thus be burdened with raised taxes (Tillinghast, 2004). On the other hand, wind developers usually pay a lease to land owners for accommodating the wind turbines, thereby resulting in increased income, potential spending, and thereby potentially increased sales tax revenues. Finally, in regions where environmental tourism is an important economic activity, wind developments can be detrimental to tourism and therefore to the businesses that serves these visitors. Surveys and research have demonstrated that people who seek to visit scenic, rural, and pastoral environments are not willing to go to places where the view could be affected by industrial devices such as wind turbines (Tillinghast, 2004).

3.7.7 Safety Considerations

Wind turbines along ROW represent a number of risks. First, any structural failure (e.g., blades or any piece falling or flinging) can be disastrous as Figure 3.49 shows. Whenever wind turbines are placed near communities or the road, the consequences are exacerbated and precautions have to be taken. An accident in November 2006 near Oldenburg in northern Germany serves as an example. A sudden gust of wind ripped the tip off of the rotor blade throwing the heavy 10-meter (32-foot) fragment a distance of 200 meters. Although no injuries or serious damage resulted, the incident raised concern. Second, if a piece of ice (i.e., snow or hail) hits the blade, it can be thrown over a long distance with high intensity, potentially resulting in accidents. In addition, the ice can damage the structural integrity of the wind turbines and, hence, create risk for the surrounding areas. Therefore, a safety radius of 750 to 1,000 feet around the wind turbine is recommended (Tillinghast, 2004). Blade and wind turbine failure is depicted in Figures 3.50 and 3.51.

Source: Piepkorn (2008)

Figure 3.49: Wind Turbine Wreck

Source: OC Safety News (2011)

Figure 3.50: Blade Failure

Source: Hoffman (2010)

Figure 3.51: Wind Turbine Failure

Third, wind turbines along ROW pose the likelihood of oil spilling from the turbine onto the road, which could present a hazardous condition if the oil makes the pavement slippery. Fourth, wind turbines can be a distraction to drivers and, thus, can provoke accidents. In England, government inspectors withdrew support for a wind power development, alleging the wind turbines would affect road safety adversely (Tillinghast, 2004). Finally, like solar panels, wind turbines placed along ROW may pose a danger for vehicles that accidentally run off the road.

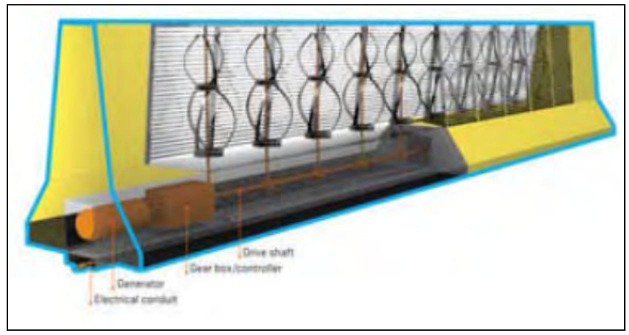
3.7.8 Examples

Perhaps the most innovative wind turbine model proposed for highway ROW was designed by a student from Arizona State University (ASU) (see Figure 3.52). As already mentioned, this model intends to harvest energy generated by the traffic turbulence and convert it into electricity. It is estimated that, at an average speed of 70 mph, each turbine could generate 9,600 KWh per year (AutoblogGreen, 2007). However, similar to the traditional wind turbines, this model presents issues related to safety (e.g., ice throw, broken parts falling, etc.) and the environment (e.g., bird kill). Furthermore, some questions remain unanswered regarding whether traffic turbulence could be maintained and keep the turbines working, as well as the efficiency of the model (AutoblogGreen, 2007).

Source: Abuelsamid (2007)

Figure 3.52: Arizona State University Contest Design

A different wind turbine model, proposed by Mark Oberholzer, is known as the New Jersey barrier (see Figure 3.53). In this model, wind turbines are embedded into the New Jersey barrier that protect or separate road lanes. This new model for harvesting energy from vehicle turbulence is still being researched. However, Oberholzer stated that the barriers “are perfectly positioned to take advantage of the wind that passing cars generate” (Cavanaugh, 2007). Oberholzer acknowledged some technical issues concerning connecting the system to the grid. This issue can, however, be overcome if the power is used on site. An example would be to install and integrate the barrier along a subway or light-rail train system.



Source: Cavanaugh (2007)

Figure 3.53: New Jersey Barrier

Finally, TAK Studio envisioned and designed a wind turbine similar to the model developed by the ASU student (see Figure 3.54). TAK Studio aims to harness the energy generated by the traffic turbulence and the wind and convert it into electricity. However, in this case, the device would supply only the energy needed to illuminate the highways. A more realistic example can be found in Israel, where the Israel National Roads Company is conducting feasibility studies (i.e., front-end planning) of installing small wind turbines tied to light poles along the coastal road, taking advantage of sea winds. Also, in Taiwan, small wind turbines are being installed at parking lots (Volpe Center, 2011).

A number of examples exist where wind turbines have been installed at rest areas to provide energy and promote renewable energy generation. In Texas, two 50 KWh wind turbines have been installed at two rest areas—on IH 40 close to Amarillo and close to Lubbock. Each turbine costs about $2 million and supplies part of the electricity used by the rest area. According to TxDOT, the wind turbines spark the curiosity of most visitors and, therefore, “promote” green energy awareness. A wind turbine project has also been explored at the Blandford rest area on the Massachusetts Turnpike (see Figure 3.55). A 400-foot-tall wind turbine with the potential to generate 1.5 MW has been considered for installation in the middle of the 68-acre site around 1,500ft from the highway. This device is expected to generate 3,000 MWh of electricity per year, enough to supply the energy needs of nearly 400 households. The electricity will potentially be sold to Western Massachusetts Electric Company or another utility provider. However, the registered voters at Town of Blandford recently defeated a wind power zoning bylaw, which raised some concerns and questions about the future and viability of the project (Volpe Center, 2011). If the project moves forward, MassDOT envisions a business model where the

Source: Voelcker (2010)

Figure 3.54: TAK Studio Design

developer pays a rent fee of 3.5% of the power sales, with a minimum of $15,000 a year guaranteed over a 20-year lease period. The Ohio DOT (ODOT) is installing a small 32KW wind turbine at a maintenance facility in Northwood, adjacent to highway ROW along IH 68. The wind turbine is approximately 100 feet tall and is located 140 feet from the roadway (i.e., setback). The wind system proposed is intended to help provide up to 65% of the electricity consumed by the facility (Volpe Center, 2011).

Source: Volpe Center (2011)

Figure 3.55: Location of proposed Blandford rest area wind turbine

CDOT, Ohio DOT, MassDOT, and Illinois DOT have worked with local consulting companies and/or universities to identify opportunity zones and sites suitable for renewable energy and revenue generating projects on highway ROWs, rest areas, and weigh stations. These opportunity zones have been identified by overlaying ROW maps and GIS data layers of potential renewable energy source (i.e., solar, wind, geothermal, and biomass resource maps) (Volpe Center, 2011).

3.7.9 Concluding Remarks

Wind turbines raise several concerns and have a number of requirements that directly impact the feasibility of this VEA:

a. site location and characteristics (i.e., electricity generation is a function of the size and characteristics of the site, including area, plainness, alternative access road, clear zone, wind obstruction, existing zoning laws, aesthetics, and average wind speed);
b. area required/impacted by wind turbines and minimum distance required between two adjacent wind turbines—small wind turbines require less area and shorter distance;
c. maintenance study and access are crucial (i.e., intensive maintenance);
d. potential issues when installing wind turbines close to communities (e.g., noise, shade, tourism, and property value);
e. potential conflicts with Texas's Highway Beautification Act and Wildflower program;

f. wind turbine height may be regulated (e.g., zoning law and FAA regulation) in some locations (e.g., neighborhood and airports). Consulting the FAA, DOD, and the Joint Program Office (JPO) at the beginning of the project and prior to moving forward with further studies and negotiations is necessary to avoid delays and unnecessary efforts and expenditures;
g. safety considerations are decisive in site and equipment selection (e.g., possible structural failure, hail and snow being thrown with power against vehicles, safety zone, oil spilled onto the pavement, and wind turbine posing as a distraction to drivers);
h. wind turbines can help to reduce the carbon footprint and attain renewable energy goals. But the wind turbines can also pose some risks to the environment, such as bird and bat deaths, noise, shadows, visual impacts, oil leaks, contamination from the detergent used to clean the wind turbines, and fires;
i. wind turbines typically have high initial costs, but better cost per KWh produced compared to other renewable energy sources;
j. in remote areas, wind energy can be an alternative or reduce cost of transmission lines;
k. business model, permit (i.e., utility accommodation, airspace lease, special use permit, and easement), and legal considerations regarding the RECs, incentives, and patents may impact the feasibility of wind energy projects;
l. contractual agreements, liabilities, and responsibilities (e.g., site security, maintenance, vacating the site, and removing the equipment, termination conditions) need to be stipulated. Shared risk agreements guarantee and long-term commitment need to be guaranteed;
m. the involvement of the State DOJ, as well as legal counsel, is always recommended to advise and review the written agreements with private parties and minimize any potential risks and undesired liability;
n. as a renewable energy source, wind turbines can reduce the carbon footprint, resulting in less dependence on fossil fuels, and enhanced sustainability;
o. upper-management support and an in-house champion, who would be responsible for leading and implementing the wind project are important;
p. effective public involvement and support are required; and
q. environmental impact analysis and assessment need to be conducted. Compliance with NEPA and other environmental regulations is essential.

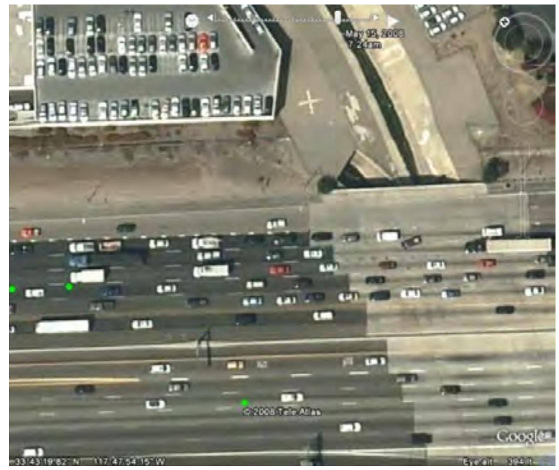
3.8 Special Road (Solar Roads/Piezoelectric Asphalt)

A number of research studies have been conducted on using the road pavement for generating electricity. Most of these applications are, however, in the development and testing stage. Solar roads, for example, are an application that uses solar panels—usually 12’x12’—in lieu of asphalt or concrete. In the case of piezoelectric asphalt, piezoelectric cells are embedded in the asphalt pavement. The piezoelectric cells convert the mechanical deformation of the pavement when traffic passes over it into electricity. Innowattech, an Israeli company, and the Technion Israel Institute of Technology are working on a pilot project that will produce an estimated 200 KWh per 0.625 lane-miles.

3.8.1 Technical Feasibility

As previously stated, both the solar road and piezoelectric asphalt application have not been proven technically feasible. In the case of the piezoelectric road application, the efficiency of the application depends on the traffic volume and vehicle weight (i.e., trucks and cars). An Associate Professor at Ryerson University in Toronto, Lloyd Alter, is skeptical of the efficiency of this application arguing that the piezoelectric road “is converting the energy from gasoline, paid for by the driver and inefficiently converted into forward motion, into electricity by increasing drag.” Furthermore, concerns exist about the impact on the pavement structure, durability, and performance. The piezoelectric cells require mechanical deformation to function; therefore, the application is limited to flexible pavements (i.e., not rigid).

In the case of solar roads, a major question is whether the panels are capable of efficiently generating energy on roads with high level of traffic and congestion. An assessment made by Solar Roadways concluded that even on congested roads, the space between vehicles is large enough to generate a reasonable amount of energy in sunlight conditions (see Figure 3.56).



Source: Solar Roadways (2010)

Figure 3.56: Orange County, CA during work traffic

Concerns also exist about the strength and loading support of the panels (i.e., structural integrity), especially for moving heavy trucks. The developers, however, assert that the panels are designed to endure heavy loads and intense traffic. Another potential concern surrounds the placing of the panels on an irregular surface and keeping the joints between adjacent panels smooth and continuous. The solution has been to embed the panels in a concrete bed. The cost of this solution, however, may make the application financially unfeasible. Thus far, the pilot test results have not been released. In the case of solar roads, for example, the developers are currently working on testing the strength of the panel and glass, as well as on the development of the electrical system.

Furthermore, concern has been expressed about how to conduct pavement maintenance and rehabilitation activities, as well as how disruptive intervention will be to daily traffic. For piezoelectric roads, in particular, the question remains: how to integrate and schedule pavement intervention with the piezoelectric cell maintenance? Finally, questions about ownership and liability remain unresolved.

3.8.2 Political/Public Concerns

In general, new inventions and technologies are often met with skepticism and concerns from users and investors and therefore need to be fully tested and proved to secure support. These applications may thus face some opposition in the short term until results regarding efficiency, reliability, and cost-effectiveness have emerged and been published. A solar road pilot project is being funded by the U.S. DOT in Idaho. The piezoelectric asphalt application, on the other hand, has evoked questions and doubts in the scientific community.

A major concern, however, is how to integrate all agencies and parties (e.g., the Department of Energy, U.S. DOT, GLO, FHWA, and utility companies) likely to be involved with this VEA to ensure that all are working together.

3.8.3 Legal Considerations

Because these applications are new and innovative, no legal or regulatory precedent pertaining to these technologies exist (e.g., the FHWA and AASHTO). Also, pavement and road design standards are not necessarily applicable to ensure the quality and performance of these applications. Specifically, concerns regarding ownership and liability of the pavement, maintenance and operation, as well as the performance and quality of the final product (i.e., solar pavement) have to be addressed. Also, although these technologies are considered “green” and renewable sources of energy, questions remain as to the incentives, credits, and RECs these applications legally qualify for. Finally, another legal issue initially involves the competitive bidding process required for most public projects. Given only one vendor, contractors and other stakeholders may plead unfair competition and hinder the implementation of the application.

3.8.4 Financial/Economic Feasibility

Because both applications are still in the development stage costs and economic feasibility information are largely unavailable. Questions about the cost of installation, frequency and cost of maintenance, system efficiency, and durability still has to be answered to have a better understanding about the prospects of the application. However, similar to other renewable energy sources, these applications may also be qualified for federal and state incentives. In addition, the infrastructure needed to implement the solar road application—i.e., the conduits—can potentially be used to acquire additional revenue through leasing it to service providers such as internet, cable TV, and telephone companies (Solar Roadways). Also, recharge stations for electric vehicles (EV) can be installed at solar parking lots or along the solar roads, adding value to the asset. Finally, the developer argues that the cost of the solar panel pavement would need to be offset by the cost of power plants, grid infrastructure investment, and traditional pavement expenditures. The developer also estimates a 20-year payback period for the solar road application A detailed study or analysis of the costs of the solar road application is not available, however.

3.8.5 Environmental Considerations

Similar to solar panels, solar roads are environmentally friendly, do not produce emissions, and are non-polluting. Therefore, solar roads do not contribute to noise, air, and effluent pollution or the carbon footprint and do require the disposal of waste. Moreover, photovoltaic panels—embedded in the pavement—do not need and use water for electricity generation. Solar panels furthermore help reduce water consumption as solar energy offsets the likely energy production from conventional energy sources, which require water (SECO, 2008). Water is a precious natural resource and has been the subject of many discussions among environmental and political groups. Researchers have argued that clean and drinkable water will be scarce in the future and, hence, using an energy source that does not require water is beneficial.

Despite the environmental benefits of solar panels, some concerns have emerged regarding the disposal of these panels at the end of their life (SECO, 2008). Photovoltaic technology uses heavy metals such as cadmium, and improper equipment disposal could harm the environment. Some solar manufacturers have, however, developed or implemented recycling programs and reprocessing techniques, which can overcome disposal issues (SECO, 2008).

Finally, both solar roads and piezoelectric pavements facilitate the implementation of electric-vehicle recharging stations along roads, thereby incentivizing the adoption and use of electric vehicles, which are environmentally friendly.

3.8.6 Potential Social Impacts/Benefits

The frequency and level of technology maintenance could potentially impact traffic flow and congestion, consequently impacting the users and nearby communities. A potential benefit, however, involves job creation as these applications would generate employment opportunities in equipment manufacturing. Furthermore, the construction of these roads (i.e., solar roads or piezoelectric roads) may be more labor intensive than traditional road projects, which are highly mechanized. Another indirect social benefit would stem from installing electric vehicle recharging stations along highways and at parking lots. These stations' increasing popularity and availability at retail stores and gas stations would enhance the practicability of using electric cars for long trips and facilitate the day-by-day operation of electric vehicles. Electric vehicle recharging stations can therefore generate extra revenue. Furthermore, solar roads' inherent capability of eliminating snow and ice accumulation on the pavement surface will eliminate school and business closures because of weather conditions (i.e., snow), benefiting students, business owners, and the community at large.

3.8.7 Safety Considerations

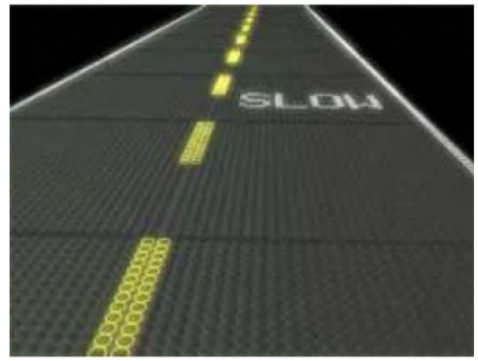
In the case of the solar road application, a major concern revolves around the skid resistance of the panels (i.e., adherence between tire and pavement), mainly in rain and snowy conditions. The solar road developers, however, argue that the solar panels are "rugged" enough to prevent skids, contain "LED lighting (to enable real-time communication with drivers)," and contain "heating units (to prevent icing)," as well as wildlife detector sensors. The LED lighting could be used to instruct drivers to "slow down" (see Figure 3.57) or inform about a detour ahead, thus yielding safer driving, conditions especially at night. Therefore, the developers assert that all these devices will enhance the safety of the roadway. On the other hand, the irregular base may result in adjacent panels not being level at the joints, causing discomfort and risk to road users. Likewise, for the piezoelectric application, possible excess pavement deformation can be detrimental to the safety and comfort of the drivers.

Source: Solar Roadways (2010)

Figure 3.57: Solar Road Module

3.8.8 Examples

Two examples of these applications are currently being piloted. In the case of the solar road, the U.S. DOT has provided $100,000 for a pilot project in Idaho to be conducted (see Figure 3.58) by the Sagle, Idaho startup Solar Roadways. Sagle aims to build a prototype solar road to assess the potential cost-benefit and technical feasibility of the technology. For this pilot project, a 36’x12’ section of a parking lot will be embedded with 12’x12’ solar panels that cost $10,000 each.

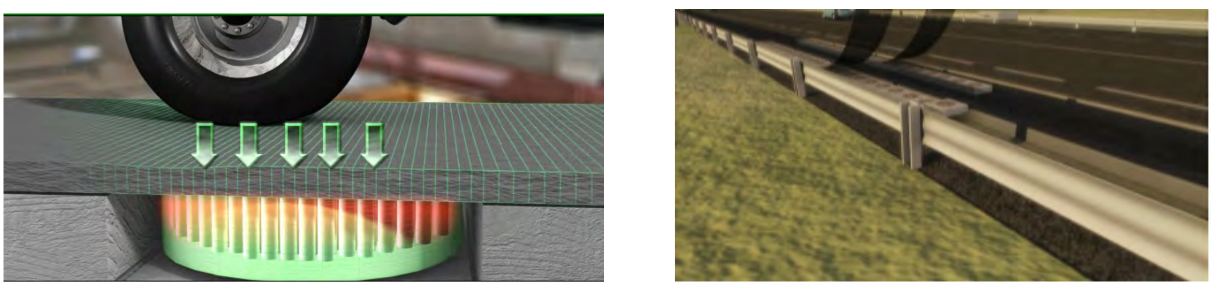


Source: Solar Roadways (2010)

Figure 3.58: Solar Road Simulation

In terms of the piezoelectric pavement application (see Figure 3.59), Israel has been the pioneer in testing the system. As part of a pilot project, Innowattech, an Israeli-based company, inserted piezoelectric generators on 33 feet of a road in Haifa at 2 inches below the surface. A major challenge was to prove that the system would not affect the integrity and performance of the pavement. Monitoring has shown that no pavement degradation had occurred. Moreover, it has estimated that half a mile of a busy lane could produce enough energy for nearly 150 homes.

In the case of both applications, no results or reports have been published.



Source: Innowattech (2010)

Figure 3.59: Piezoelectric Cell Illustration

3.8.9 Concluding Remarks

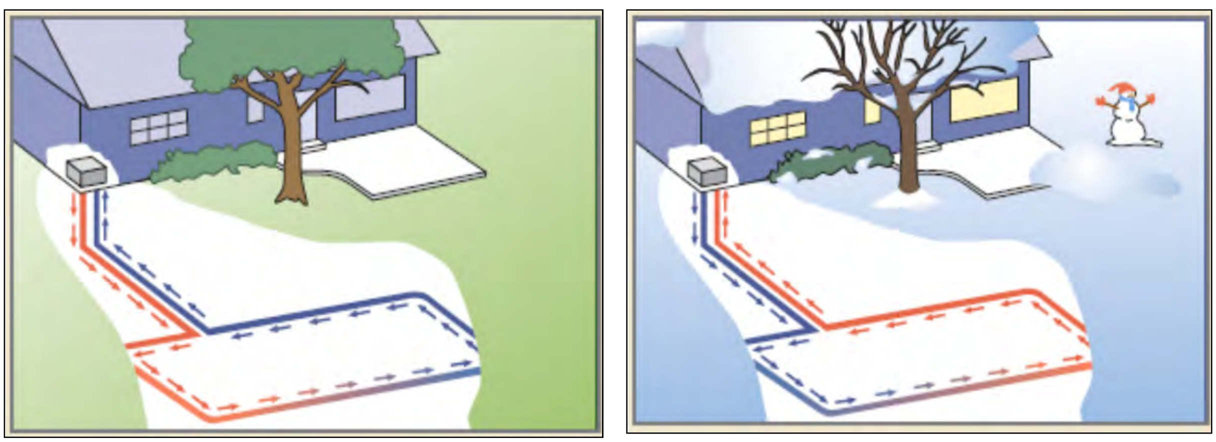
Because both of these applications involve new technologies that are still in the testing stage, very limited data and information are available. Major considerations thus are limited to the following:

a. the need for a different business model given the parties involved (i.e., DOT, utility company, DOE, vendor, and investor);
b. skepticism of some pavement engineers about the efficiency and reliability of the piezoelectric pavement system;
c. concerns about ownership of the pavement and maintenance, as well as liability;
d. solar road can enhance road safety (e.g., LED lighting can transmit messages to drivers, snow and ice prevention, wildlife detection), but also raise some concern (e.g., light reflection, pavement roughness and skid resistance); and

e. concerns about the pavement structure (e.g., deformation).

3.9 Geothermal and Carbon Energy

Geothermal energy is a renewable energy source that involves the use of the "earth's heat" to generate electricity and/or hot water. The "earth's heat" can be extracted in two manners. First, by drilling wells deep into the earth, electricity can be produced using heated water (i.e., hydrothermal heat). Second, in areas where the earth's surface has high temperatures, geothermal heat pumps (GHP) can be used to heat and cool buildings by exchanging heat between spaces (SECO, 2008). The heat pump system is the simplest way to exploit geothermal energy and is composed of pipes buried near the surface of the ground—e.g., ground with high surface temperature—and fluid (usually water) circulating between the pipes and the pump (see Figure 3.60). Similar to an air conditioner or furnace, the fluid exchanges heat between the ground and the building. This system is generally used when the outside temperature is uncomfortably cold or hot (Wendell et al., 2003). Geothermal systems—similar to GHP—have been applied as a de-icing mechanism on highways since the late 1940s. In this system, "heat pipes" are embedded in the pavement, where snow or ice layers have formed in the past. Recent observation has revealed that geothermal systems could keep the pavement free of snow and ice at temperature as low as -10^{o}F (-23^{o}C). Several DOTs have implemented a geothermal system at problematic locations, including New Jersey, South Dakota, Wyoming, and Virginia DOT, as well as countries such as Japan, Switzerland, and Argentina (Volpe Center, 2011).



Source: Wendell et al. (2003)

Figure 3.60: Heat Pump Operation

3.9.1 Technical Feasibility

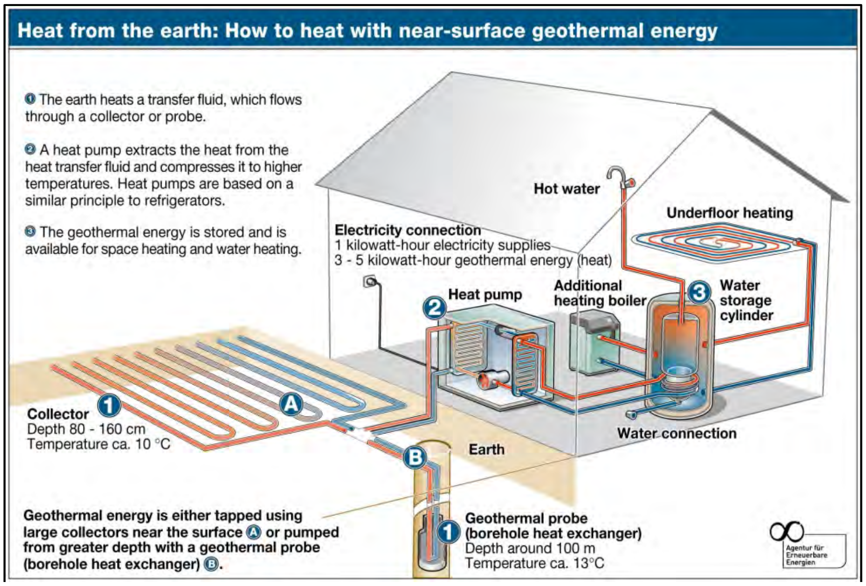
Geothermal energy is potentially an important natural resource that is constant and unaffected by changes in the earth's surface conditions that affect other renewable energy sources (SECO, 2008). The greatest advantages of geothermal energy are that it can be generated a) on a small scale and b) anywhere in Texas. The major challenges, however, are to determine where and how deep the geothermal resources are located and how to get to and exploit the resource (SECO, 2008). Basically, four different geothermal energy exploitation methods can be used depending on the underground characteristics (see Table 3.6). In areas with low soil temperature, the heat pump can be applied as the geoexchange system. The GHP (see Figure 3.61) transfers heat between warm and cool areas and can be implemented at offices and rest areas. Geothermal heat pumps are typically integrated with HVAC systems, improving their efficiency and, consequently, saving electricity. The U.S. Environmental Protection Agency (EPA) regards the GHP as the most energy-efficient, environmentally clean, and cost-effective method of temperature control (SECO, 2008). In areas with high soil temperature and enough energy for electric power generation, a geothermal power plant can be implemented. In a traditional geothermal power plant, a well is drilled to extract steam and water from a geothermal reservoir. The steam is separated from the water and conducted to turbines that generate energy. The steam is then condensed and either disposed of or reused (see Figure 3.62). Finally, areas with hot water available can use the hot water directly for several purposes. The State Energy Conservation Office (SECO, 2008) lists potential direct uses as (a) generating electricity for industrial heating needs, (b) fish farming, (c) food processing, (d) pasteurizing milk, (e) spa and hot springs, (f) nurseries, and (g) residential and commercial heating. In Texas, extensive experience and knowledge exist about soil features and composition, because of the oil and gas exploration in the state. Detailed analyses of heat resources, reservoirs, and deep water availability can thus be readily accessed. In fact, the existing oil and gas wells can be used for generating thermal energy, thereby reducing the investment required (SECO, 2008).

Table 3.6: Classification of Geothermal Energy

Source: SECO (2008)

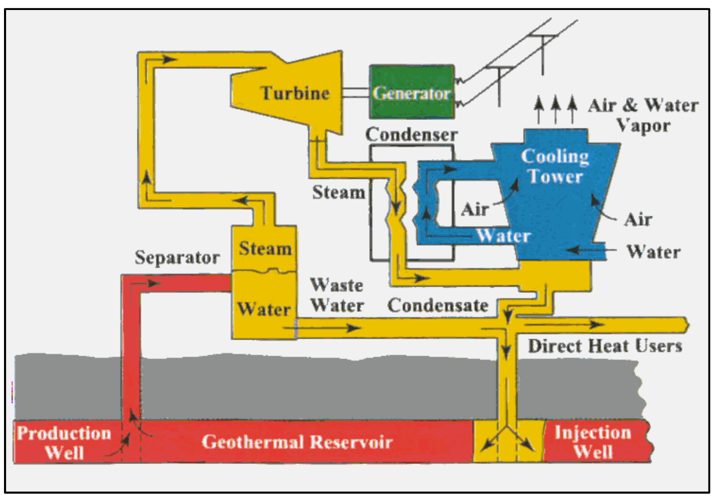
Resource Temperature	Best Applications for Geothermal Heat*
Surface Temperature (40°F to 80°F)	Geothermal HVAC systems for homes and buildings
Low Temperature (70°F to 165°F)	Direct use: agriculture and greenhouse, aquaculture (fish farming) mineral water spas and bath facilities, district water heating, soil warming, fruit & vegetable drying, concrete curing, food processing
Moderate Temperature (165°F to 300°F)	Binary fluid generators for electrical production; Direct use: absorption, chillers, fabric dyeing, pulp and paper processing, lumber and cement drying, sugar evaporation
High Temperature (>300°F)	Electricity production, minerals recovery, hydrogen production, ethanol and biofuels production

*Uses of geothermal energy adapted from the Geothermal Education Office materials.



Source: ESM (2010)

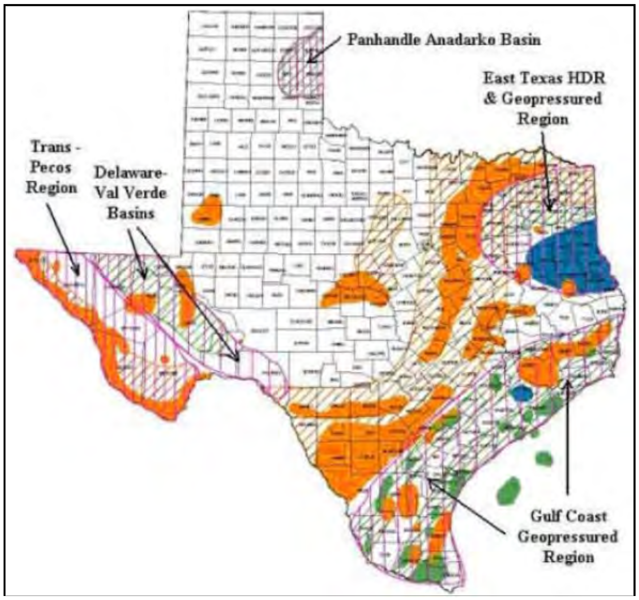
Figure 3.61: Generating Geothermal Energy



Source: Planet Earth and Humanity (2010)

Figure 3.62: Geothermal Energy Process

SECO has worked with Southern Methodist University's Geothermal Laboratory and The University of Texas at the Permian Basin to analyze and determine the potential for geothermal energy generation in different regions of Texas. Figure 3.63 illustrates the available geothermal resources across the state. The orange color depicts where hydrothermal resources can be explored for space heating, fish farming, desalinization, and resort spas. Hydrothermal resources are defined as hot water and/or steam found in fractured or porous rock at moderate depth. The green color depicts geopressure resources that can be used for heating, enhanced oil recovery, and electricity generation. Geopressure resources are hot brine water saturated with methane recovered from large and deep aquifers under high pressure. Finally, the blue color depicts areas



Source: SECO (2008)

Figure 3.63: Texas Geothermal Map

with hot dry rock that can be used for heating and electricity. Hot dry rock is a heated geological formation and, unlike hydrothermal resources, it does not contain water.

In addition, the map also depicts five regions in Texas that have great potential for geothermal electrical power generation (SECO Website). It should be noted that only a few Texas aquifers have been analyzed and their thermal characteristics assessed (SECO, 2008).

The major advantage of geothermal energy over solar and wind energy is that electricity generation does not depend on weather conditions, seasons, or time of day. Therefore, battery backup systems are not required. Furthermore, geothermal power plants are reliable, going off-line only about 5% of the time. The plants can be located in major population centers or rural communities and scaled to meet demand. In serving major population centers, the existence or need for transmission lines has to be evaluated and considered as it often determines the technical and financial feasibility of geothermal projects.

3.9.2 Political/Public Concerns

Geothermal energy exploration has sparked the interest of the Texas and federal legislatures. For example, Executive Order 13514 issued by President Obama sets up "an integrated strategy toward sustainability in Federal Government and to make reduction of greenhouse gas emissions a priority of Federal agencies." Likewise, the FHWA is endorsing and promoting the incorporation of climate change considerations into the transportation decision-making process. A few permits have already been awarded by the Texas government and GLO to explore this energy resource on public lands. On the other hand, some concerns have emerged regarding the impacts on communities and the environment (e.g., use or contamination of water, noise, and steam from power generation, as well as impacts on land value).

3.9.3 Legal Considerations

Because geothermal energy uses underground natural resources, some legal issues may exist regarding ownership and the exploitation of the natural resource. As noted earlier in this review, TxDOT will have to consider how such geothermal VEAs will impact safety, maintenance, operation, congestion, and the beautification of the highway system, as well as whether these were appropriate types of leases for highway asset property. Further legal considerations involving P3s, liabilities, long-term commitment, shared risk, incentives, and RECs, must be carefully assessed and addressed. In addition, MassDOT points out the importance of verifying local zoning laws prior to moving forward with an application. MassDOT argued that most cities do not have revised zoning laws to address and regulate renewable energy projects. A lack of zoning law can defer or even deter the implementation of geothermal projects. Another issue is the proximity to public and military airports and likely interference or obstruction with air traffic, aircraft navigation/communication systems, and military radars. For any construction over 200 ft, the form "74601-Notice of Proposed Construction or Alteration" must be filed with the FAA prior to its outset. The FAA and the DOD will review the form and issue a permit. Typically, sites that are not within 3–5 miles of an airport are not deemed hazardous to air traffic (Volpe Center, 2011). Environmental analysis is also a requirement for any renewable energy project on public land. A project must be in compliance with NEPA—i.e., follow the FHWA DOE process, if not both—to receive an environmental permit. Ultimately, if the project is located in highway ROW, the FHWA has to review all documents (e.g., permits, drawings, analysis of impacts, and contractual agreements) associated with the project to issue a final permit, allowing the project to move forward. Furthermore, whenever the project involves partnership with a third party, the Oregon DOT (ODOT) recommends the involvement of the DOT's General Counsel (and on occasion the Attorney General) to review any contracts with private parties to minimize any potential risks and undesired liability to the DOT.

3.9.4 Financial/Economic Feasibility

The geoexchange system (i.e., heat pump) can be expensive to install. However, the initial investment cost can be recovered in an estimated 2 to 10 years from energy savings associated with heating and cooling systems. Hence, heat pumps can be very cost-effective (SECO Website). Nonetheless, direct use of hot water is by far the cheapest form of geothermal energy.

The cost of a geothermal power plant is a function of the energy generation capacity of the proposed plant. Regardless of the installed capacity of the power plant, a major cost component is the drilling of the well to reach water hot enough for power generation. Sometimes, the wells are thousands of feet deep, thus significantly increasing the installation cost. On the other hand, the power resource can continuously operate at very low costs and with no carbon footprint (Lxrichter, 2010).

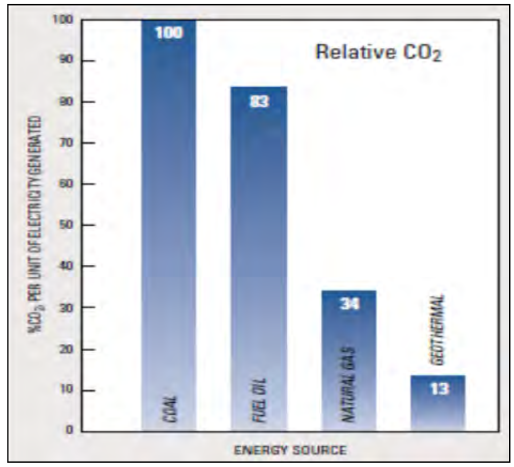
The U.S. Bureau of Land Management (BLM) is a pioneer in leasing federal land for geothermal energy development. From 2007 to 2010, the BLM generated more than $57 million in auctioning off leases for exploiting geothermal resources on federal lands in Idaho and nearby states (Lxricther, 2010). In Texas, most of the state has geothermal resources that can be accessed for electricity production. Economic feasibility, however, varies with the quality of the resource—i.e., its temperature, depth, and fluid characteristics—and the ease and rate with which the geofluids can be extracted and then reinjected (SECO, 2008). These factors depend on the site geology and have to be carefully analyzed prior to proceeding with a project. In general, the payback period for geothermal power projects is 10 to 30 years due to the high upfront investment required.

Geothermal energy projects are also eligible for federal and state incentives. Furthermore, the financial feasibility of geothermal energy projects is usually influenced by the electricity price of conventional sources. In Texas, the price of electricity must be in excess of $0.08 per KWh for geothermal electricity production to be financially competitive. This number, however, varies from area to area given the quality of the resource and the need for transmission lines.

3.9.5 Environmental Considerations

The GHP does not impose significant negative environmental impacts. Geothermal energy is also considered a relatively clean energy source because it emits much less carbon dioxide than fossil fuels (see Figure 3.64). In addition, a geothermal power plant also has a comparatively small surface footprint.

A major concern, however, involves the use of water. Geothermal energy production requires large amounts of water that often contain dissolved toxic substances that are reinjected into the earth. The availability, quality, and mainly the disposal of water raise major concerns. Similar issues pertain to the direct use of hot water. The use and disposal of water have to be studied and considered carefully to avoid waste or contamination of aquifers. Special treatments, techniques (e.g., closed loop systems), and interventions may be needed. Furthermore, the ability of the aquifers to endure long-term high-flow rates has to be analyzed early on in project developments.



Source: Wendell et al. (2003)

Figure 3.64: Relative CO2 Emission

Finally, some concerns may emerge regarding the noise and steam generated on nearby communities and wildlife habitat. These impacts are typically associated with geothermal power plants and depend on the size/capacity of the system, as well as the technology used.

3.9.6 Potential Social Impacts/Benefits

GHPs can reduce grid energy consumption thus saving money. Although GHPs are not feasible in ROWs, they can potentially be implemented at rest areas and offices, specifically facilities in rural areas. Geothermal energy produced can provide electricity at relatively low costs because it can be produced close to the end-user, thereby reducing the need for transmission lines. As previously mentioned, electricity is important to promoting social welfare, quality of life, and economic development.

3.9.7 Safety Considerations

Geothermal energy is in general a safe energy resource. However, if existing oil and gas wells are used for geothermal energy production, precautions must be taken to prevent explosions or fire. Geothermal power plants are not recommended for implementation in highway ROW (i.e., close to the road) because, among other considerations, the water and steam generated may pose a safety risk for the road users, especially steam that can resemble fog. On the other hand, implementing geothermal systems (i.e., GHP) to avoid the icing of roads or directly using hot water to de-ice the pavement can help to maintain the pavements skid resistance during cold weather (i.e., winter), thereby enhancing road safety.

3.9.8 Examples

Figures 3.65, 3.66, and 3.67 illustrate a number of ways to harness geothermal energy. As mentioned, GHPs (see Figure 3.65) are widely used nationwide. The size and complexity of GHP systems depend on the HVAC systems used and the amount of electricity that is intended to be saved. Figure 3.65 depicts a typical system used in homes and small buildings (e.g., school). Another typical geothermal energy application is geothermal power generation. Like GHPs, the size of the geothermal power plants varies with capacity (i.e., maximum electricity generated). For office buildings and warehouses, a small generator (see Figure 3.66) may provide all the electricity used in these facilities, whereas for larger demand power plants must be built to provide the electricity needed (see Figure 3.67). However, in the latter case considerable area and investment are required.

Geothermal heat pump installation (loop water pumps and piping).

Presently, many Texas homes, schools and other buildings are using geoexchange systems to take advantage of the cost savings in heating and cooling the inside of a building.

Source: SECO (2010)

Figure 3.65: Heat Pump System

Source: PBPA (2009)

Figure 3.66: Geothermal Power Generator

There is an increasing interest in geothermal development in the state of Idaho, as show in more than 80 applications for geothermal leases just in recent weeks.

Source: Lxrichter (2011)

Figure 3.67: Geothermal Power Plant in Idaho

3.9.9 Concluding Remarks

Geothermal energy generation can potentially be explored in Texas. The main considerations in implementing this VEA are the following:

a. there are different uses of geothermal energy (e.g., GHP, direct use, and electricity generation);
b. site location and characteristics are important (e.g., area, alternative access road, clear zone, existing zoning laws, and available underground resource);
c. GHP systems can be implemented almost anywhere in Texas and the upfront investment can be recovered in 2 to 10 years through electricity savings;
d. GHP systems do not require any private party involvement or partnership;
e. direct use and electricity generation are a function of the underground geothermal characteristics (e.g., temperature and water availability). The implementation cost is also a function of the underground conditions (e.g., depth needed to reach certain temperature and geotechnical properties). Typically the payback period for geothermal power plants is 10 to 30 years
f. geothermal resources do not depend on weather conditions, season, or time of day;
g. electricity generation may cause safety concerns (e.g., steam), require a considerable area, and impact communities and wildlife habitat (e.g., noise, water, and steam). On the other hand, a GHP system embedded in the pavement and/or direct use of hot water can help to prevent snow and/or an ice layer from forming; thereby enhancing road safety in cold weather (i.e., winter);

h. the business model adopted, the permit type (i.e., utility accommodation, airspace lease, special use permit, and easement), and applicable incentives and RECs must be carefully assessed. Concerns about the ownership of the natural underground resources may also exist;
i. contractual agreements, liabilities, and responsibilities (e.g., site security, maintenance, vacating the site and removing the equipment, termination conditions, and ownership of the RECs) must be clearly understood;
j. the involvement of the State DOJ and legal counsel are always recommended to advise and review the written agreements with private parties and to minimize any potential risks and undesired liability for the DOT;
k. legalities such as zoning laws and FAA permits must be considered;
l. upper-management support and an in-house champion, who would be responsible for leading the entire implementation process, are important; and
m. as a renewable energy source, geothermal energy can be important to reduce emissions, reduce the dependence on fossil fuels, and enhance sustainability.

3.10 Carbon Sequestration and Biomass

3.10.1 Carbon Sequestration

Carbon sequestration is the process of capturing and removing CO_2 and other forms of carbon from the atmosphere and then "storing" it in "reservoirs." A variety of techniques to sequester carbon exist, but the focus here is exclusively on vegetation management. The objective is to improve vegetation management through the implementation of a modified and sustainable mowing approach. Furthermore, the Carbon Sequestration Pilot Program (CSPP), led by the FHWA's Office of Natural and Human Environment (ONHE) and the New Mexico DOT (NMDOT), reported that in addition to improved vegetation management, carbon sequestration allows for "(1) selling carbon credits on an appropriate GHG market or registry for revenue, (2) using carbon credits to offset the DOT's emissions, or (3) using the credits toward meeting statewide objectives" (FHWA and Volpe, 2009). The goals are thus to reduce mowing expenses and/or generate revenues from selling carbon credits on a carbon market.

3.10.1.1 Technical Feasibility

A major concern regarding the implementation of carbon sequestration programs is that the carbon sequestered has to be clearly demonstrated as "additional" compared to a realistic calculated baseline and emission reduction projection. This requires that a comprehensive analysis be conducted to identify the current baseline, the carbon sequestration rate, and, subsequently, the additional carbon sequestered. A GIS can be an important tool to establish a baseline in a specific year (TTI, 2001). Furthermore, carbon sequestration programs require the involvement of two technical entities: a carbon aggregator and a carbon verifier. Carbon aggregators are brokers who represent small projects in the carbon market. Carbon aggregators collect carbon credits from small projects and efficiently trade them as large blocks for a fee. The carbon aggregator can be in-house. The NMDOT, for example, envisions the opportunity to become its own aggregator by partnering with other states (FHWA, 2009). Partnership can avoid the cost of hiring a third party and can also help ensure that a substantial volume of carbon is sequestered to earn a good return in the market. The carbon aggregator has to work in harmony with a carbon verifier. The carbon verifier is responsible for ensuring the enrolled land complies with the established protocol to enter into the carbon market. The NMDOT points to the importance of understanding carbon verification, the requirements, and how to meet the requirements in terms of ecological and biological analyses, and the economic considerations. Available carbon verifiers with expertise in the ecoregions and regional native grasses are, however, limited (FHWA, 2009). Involving staff with knowledge of the process to better assess risks, rewards, and next steps in quantifying, verifying, and selling carbon credits is also considered important. This is because some physical ROW characteristics (e.g., precipitation, soil, temperature, and standing crop) impact the potential carbon that can be sequestered (FHWA, 2009). The CSPP has focused on quantifying and evaluating the viability and efficiency of carbon sequestration using grasslands along highway ROW. Although the program is being conducted in New Mexico, the results are expected to be applicable nationwide.

In Texas, a major impediment to an extensive and widely adopted carbon sequestration program is the long-term commitment of up to 30 years needed to qualify for the carbon credits. Thus, utility access to state highway ROW and future road expansion will prohibit TxDOT from committing portions of its ROW to carbon sequestration programs. Also, TxDOT has ceased to mow several areas of ROW—mostly in very remote areas—and has reduced mowing in all other areas as much as possible. Currently, TxDOT mows most areas only two times per year (April and November) to save costs. Opportunities for securing "additional" credit through vegetation management as part of a carbon sequestration program are thus regarded as limited. On the other hand, beautification programs, such as the Green Ribbon Project—a corridor aesthetic and landscape master plan—requires TxDOT to plant a certain number of bushes and trees per year along TxDOT ROW. TxDOT could potentially receive carbon credits from these programs as bushes and trees absorb more carbon than grasses and flowers.

3.10.1.2 Political/Public Concerns

Global warming and GHG emissions are concerns that have fostered intensive public and political discussion and involvement. In general, policies that enhance road aesthetics and combat global warming may be well supported by the public. Also, because carbon sequestration could potentially save mowing costs (at a minimum) and/or generate revenue (at a maximum), public support (in general) is anticipated.

In the case of carbon sequestration and carbon trading, the federal government has given special attention to these applications in U.S. congressional debates centered on proposed national climate change legislation. There is special emphasis on minimizing the cost of cap-and-trade systems and/or supporting the sale of carbon offsets to ensure a potential revenue stream for those who want to implement carbon sequestration as a land management strategy (FHWA 2010).

In Texas, there is concern that this VEA may compete with and/or affect the ongoing roadside beautification and wildflower programs.

3.10.1.3 Legal Considerations

Major concerns regarding the carbon sequestration program involve the lack of regulations and/or direction in terms of a DOT's ownership of the carbon credits generated by vegetation management practices on federal lands and how these carbon credits can be traded by a public agency.

While Texas statute allows public utilities to locate their infrastructure in the ROW of state-owned highways, the provisions within the Transportation Code (TC) and Texas Administrative Code (TAC) set out duties and liabilities of the parties for such transactions. Utility providers may be concerned about being liable for any damage to vegetation planted along the ROW and may seek to have priority over a carbon sequestration program. However, under TAC Rule 21.602 any leases of highway assets—under any written lease drawn up—requires TxDOT approval of all construction plans and permission for employees to enter the property for inspection, maintenance, or reconstruction purposes.

43 TAC Chapter 21 also sets out the rules for leasing of highway assets. Under the terms of the contract the lessee will be required to include

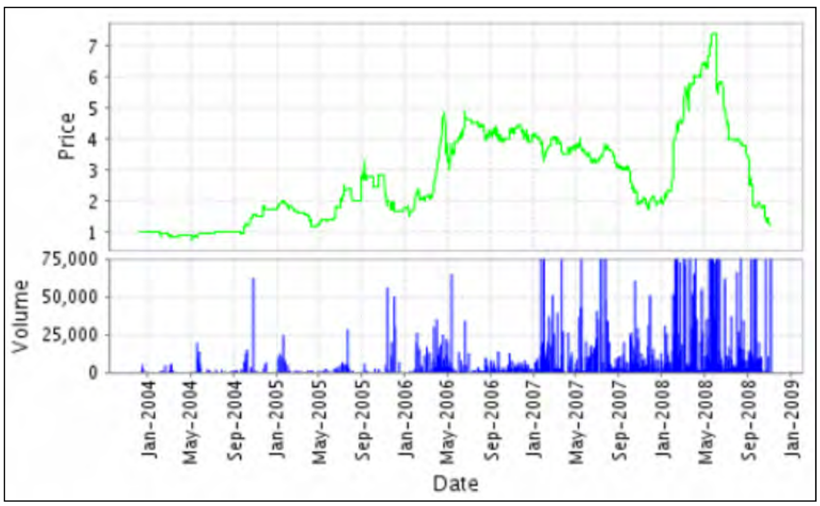
- a statement on the authorized use of the leased asset and the requirement that any change of use requires prior written approval of the director of the department,
- a requirement for department approval of all construction plans regarding the asset,
- permission for employees of the department to enter the property for inspection, maintenance, reconstruction of highway facilities as necessary, or to determine lease compliance,
- that any improvements will be maintained by lessee at their expense, and must be kept in good condition for safety and appearance and not interfere with highway use,
- a statement requiring forfeiture of the deposit, payment of litigation costs or other expenses due to nonperformance of the lease terms,
- a performance bond,
- adequate public liability insurance for the leased asset, conduct of lessee's business, and their indemnifications and obligations to the department, to be paid for by lessee and naming the department as an additional insured, and include other endorsements acceptable to the department for damages occurring to the highway facility, or for public or personal injury, loss of life, or property damage. The director can waive this requirement where the lease is with a county, city, state agency or federal government if they assume specific responsibility for such payments, that the lessee assumes all risk of losses resulting from the lease, and
- any other provisions deemed necessary or desirable by the director

As noted, any lease for such sequestration projects on or adjacent to the ROW (federal and state) will also have to comply with the provisions of CFR, TC, and TAC and not compromise, mobility, safety, and the ability of the DOT to control its assets in the best interest of the general public.

3.10.1.4 Financial/Economic Feasibility

TxDOT currently spends about $40 million per year in general mowing and $10 million on curbside vegetation. By reducing mowing frequency, maintenance expenditures, as well as GHG emissions emitted by maintenance equipment, can be reduced. TxDOT believes that it already reduced mowing activity to the maximum extent possible.

A financial analysis of a carbon sequestration program is quite complex. The FHWA has funded the development of a Carbon Sequestration Estimator Tool to estimate the potential revenue generated by carbon credits. In general, the costs of a carbon sequestration program include the expenses associated with vegetation planting and maintenance, the carbon aggregator, the carbon verifier, and internal personnel. The valuation of the benefits is even more complex. For example, conclusive research is lacking on the efficiency of carbon sequestration, the establishment of a carbon baseline, and the real rate of carbon sequestered by grass. NMDOT is currently undertaking a study to establish a protocol for carbon credits for grasslands that—once approved by the carbon trading market—can be implemented nationally. On the other hand, the revenues generated are a function of carbon prices, management techniques, and ecological variability. Therefore, these revenues may vary substantially from state to state. At the same time, the carbon credit trading or offsetting markets are still developing and are not well established. As an example, the Chicago Climate Exchange (CCX) was launched in 2003 (FHWA 2009). Similar to the stock market, the price of carbon floats, making the future revenue predictions uncertain. Figure 3.68 illustrates the fluctuation in the carbon price on the CCX market from 2004 to 2009 (FHWA 2009).



Source: FHWA (2009)

(Prices are reported in dollars per metric ton of CO_2.)

Figure 3.68: CCX Carbon Price Fluctuation

The CSPP, led by the ONHE and NMDOT, reported that in addition to improved vegetation management, carbon sequestration allows for "(1) selling carbon credits on an appropriate GHG market or registry for revenue, (2) using carbon credits to offset the DOT's emissions, or (3) using the credits toward meeting statewide objectives" (FHWA and Volpe Center, 2009).

In both cases, the carbon verifier typically charges a commission of 5 to 20% of the amount of carbon credits sold in the market. A considerable amount of carbon thus has to be sequestered to cover the total cost of the program and be attractive to the verifier. The Jornada Experimental Range project warns that for carbon sequestration to be financially feasible, the verification process has to conclude that storing the carbon costs less than the value of the carbon if sold in the market (FHWA, 2009). To reduce the implementation costs (e.g., labor, seeds, and watering) of the carbon sequestration program, the FHWA strongly recommends the use of native and self-sustaining vegetation (FHWA, 2010). Moreover, the FHWA recommends the consideration of vegetation that also serves other purposes (e.g., safety enhancements and erosion prevention) to increase the financial feasibility of a carbon sequestration program.

3.10.1.5 Environmental Considerations

The primary objective of carbon sequestration is to mitigate global warming by reducing the carbon in the atmosphere. Also, an effective vegetation management program can create a natural barrier for animals, thereby helping to preserve species.

3.10.1.6 Potential Social Impacts/Benefits

A carbon sequestration program can improve air quality by reducing the amount of CO_2 in the atmosphere. Therefore, a carbon sequestration program can help to prevent human respiratory diseases and enhance quality of life. In addition, by saving mowing and maintenance costs, the DOT can divert more resources to highway system improvements (i.e., pavement maintenance), thereby benefitting the traveling public.

3.10.1.7 Safety Considerations

A good vegetation management strategy—crucial for a carbon sequestration program—enhances road safety and prevents roadside erosion. Vegetation along highway ROW defers erosion by reducing landslides, controlling invasive plant species, retaining storm water, and holding snow (i.e., living snow fence). Appropriate vegetation can provide a natural protection barrier for coastal roads, along hills and valleys, and against animals, thereby reducing animal-vehicle collisions. On the other hand, some precautions may be necessary because some vegetation can attract animals—for feed or for use as shelter—and reduce the visibility and the sight range of drivers (e.g., trees and tall grasses), thereby increasing accident risk. In addition, woody vegetation (e.g., trees) can pose hazardous obstacles for drivers that run off the road. To overcome safety concerns, the Tennessee DOT recommends a clearance (i.e., safety zone) of at least 30 feet from the road edges for vegetation (i.e., trees and switchgrass).

3.10.1.8 Examples

The U.S. has no formal carbon sequestration programs besides the pilot programs and research studies being conducted in New Mexico and Utah.

3.10.1.9 Concluding Remarks

Following are the main considerations of carbon sequestration as a VEA:

a. the lack of a well-established carbon market;
b. requires long-term commitment and an assessment of the need for future road expansions
c. potential to interfere with utility companies and ROW access;
c. only the additional amount of carbon sequestered is considered when determining carbon credit;
d. requires an expert consultant/staff member (i.e., carbon aggregator and carbon verifier) to attest, validate, and sell the carbon credits;

e. the lack of an established protocol for grass, which is needed to quantify the carbon sequestered and enter in the carbon market; and
f. Texas's soil and weather conditions vary substantially, which directly influence the capacity, feasibility, and cost of sequestering carbon.

3.10.2 Biomass

Biomass, such as wood, waste, (hydrogen) gas, alcohol fuels, and plant matter, is typically used as a renewable energy source to generate electricity or produce heat. Although several sources of biomass exist, such as solid waste, urban waste, and construction residue, the most common sources are crops, including sugar cane, switchgrass, sorghum, oilseed crops, and grains (SECO, 2008). The Tennessee Department of Transportation (TDOT), for example, is conducting a pilot project with Genera Energy LLC—a Knoxville-based renewable energy company—using switchgrass planted on a few test plots along the highway ROW. "Switchgrass is one of the primary feedstock used to produce cellulosic ethanol" (Genera Energy, 2010). TDOT is evaluating the potential for reducing the cost of grass mowing, using the biomass for energy production, and combat roadside erosion. Concurrently, the Utah DOT (UDOT) and Utah State University (USU) are assessing the viability of planting oilseed crops on highway ROW for biofuel production.

In the case of biomass production, the goals are typically to reduce mowing expenses and/or generate revenues from harvesting certain types of crops used for biofuel production.

3.10.2.1 Technical Feasibility

In the case of biomass energy production, Texas "contains one of the most diverse and most accommodating growing environments in the United States, and boasts a plethora of potential biomass-based renewable energy sources" (SECO, 2008). For example, biomass sorghum, sugar cane, and switchgrass are important potential energy sources as lingo-cellulosic feedstock in Texas. The production of each specific crop will largely be determined by available land, rainfall, competition with nature vegetation, producer interest, economic incentives, and equipment needed. Corn is also a potential feedstock for biofuel production in Texas, but it is not considered a "dedicated energy crop" as it has different uses besides energy production. TxDOT sows approximately 70 different seed mixes along the highway ROW for erosion control to comply with the wildflower program. These seed mixes vary by region, but none contain any major oil seed or are intended for biofuel production.

Water availability is crucial for most agriculture activity. Although some drought-tolerant crops exist, it is generally believed that it would be very difficult to cultivate crops for biofuel production in areas with less than 14 to 16 inches of rainfall (Hank, 2011). Another important factor is the condition and characteristics of the soil. Different crops grow differently depending on the soil and weather conditions. Also, de-icing products (e.g., salt) and run-off water can affect and change the proprieties of the soil in the ROW, hindering the growth of crops. Regarding the latter, Hank (2011) reported that in the Utah pilot project, this issue was not encountered because of how the roads are designed. To facilitate drainage, pavements are designed to move water from the road and drain it to a specific point. This prevents contaminated water (i.e., containing oil and salt) from seeping into the adjacent soil. In Tennessee, a major challenge was to establish the switchgrass—which can take up to 3 years even if chemical fertilizers are used. About 15–20% of the four acres (divided into eight plots) used for the

Tennessee pilot project had to be re-planted. The most common problems encountered were lack of moisture, high level of soil compaction, and defects in the seed drill. Moisture is a critical factor in the success of planting. It is recommended to use land that has on average 16 inches of annual rain and to conduct planting during the rainy season. On sites with competing native vegetation, herbicides have to be used during the first year until establishment. In addition, humus may be applied during the second year.

The distance to the refinery is also an important factor in the feasibility of biomass production. For example, in the case of sugar cane and sweet sorghum (e.g., switchgrass), the sucrose for energy production must be extracted within 24 to 48 hours after harvesting. Therefore, planting has to be near the biorefinery. TDOT suggests 50 miles as the longest distance between the plot and the refinery. The distance influences the technical and financial feasibility of biomass production. In Texas, the areas along the Gulf Coast and in the northeast have the highest potential for biomass production because of existing refining capacity, strong producer networks, and available fertile land.

On the other hand, the logistics for vegetable oil is less complicated because the oil is contained in the crop seeds. Cotton is the major oilseed crop in Texas, although other crops also have some potential. Table 3.7 provides information on oilseed crops, including their characteristics and potential.

A final issue of concern is the harvesting frequency and the harvesting procedure (i.e., manually or with machinery) (SECO, 2008). The ROW features (e.g., width and steepness) and the geographic characteristics (e.g., weather), and factors such as equipment and workforce availability may impose some challenges. TxDOT's ROW varies from 30 to 700 feet wide and from flat to very steep. A GIS database that captures the geospatial characteristics of TxDOT's ROW would aid in the identification and determination of which ROW parcels are appropriate for biomass production.

Table 3.7: Oilseed Crops' Characteristics

Source: SECO (2008)

Crop	Major, Minor or Potential (World)	Cool or Warm Season	Perennial or Annual	Oil Percentage
Cotton	Major	Warm	Annual	17
Soybean	Major	Warm	Annual	18
Peanut	Minor	Warm	Annual	45
Canola	Major	Cool	Annual	40
Flax	Minor	Cool	Annual	35
Sunflower	Major	Warm	Annual	42
Safflower	Minor	Warm (and cool)	Annual	42
Sesame	Minor	Warm	Annual	50
Tung	Potential	Warm/ Subtropical	Perennial	35
Palm	Major	Warm/ Tropical	Perennial	35
Camelina	Potential	Cool	Annual	40
Brown Mustard	Potential	Cool	Annual	40
Castor	Potential	Warm	Annual	50
Chinese Tallow	Potential	Warm	Perennial	31
Jatropha	Potential	Warm/ Subtropical	Perennial	35

Source: Dr. David Baltensperger, Texas A&M University, Soil and Crop Sciences

3.10.2.2 Political/Public Concerns

Global warming and GHG emissions are a global concern that can initiate intensive public and political discussion and involvement. For example, Executive Order 13514 issued by

President Obama sets up "an integrated strategy toward sustainability in Federal Government and to make reduction of greenhouse gas emissions a priority of Federal agencies." Likewise, the FHWA is endorsing and promoting the incorporation of climate change considerations into the transportation decision-making process. Furthermore, the federal government has specifically endorsed the development and use of domestically produced biofuel for transportation as an alternative to imported fossil fuels. In addition, the Energy Independence Security Act of 2007—intended to reduce the national dependence on fossil fuel—has launched as its primary strategy the augmentation of biofuel use in the nation's vehicle fleet. Initiatives that enhance road aesthetics and support energy independence may be well supported by the public. Also, because biomass production could potentially save mowing costs (at a minimum) and/or generate revenue (at a maximum) public support (in general) is anticipated. In the case of the Tennessee pilot project, for example, the perception at first was positive, but then concerns and questions arose regarding the expenses and possible subsidies. TDOT argues that, should this VEA reach a large scale of implementation, an intensive awareness initiative and feasibility demonstration will be necessary to justify the upfront investment and secure the support of political and public entities.

In Texas, there may be concern about this VEA impacting or affecting the state's roadside beautification and wildflower programs. Some crops do not create the same aesthetic effect as the flowers of existing programs.

3.10.2.3 Legal Considerations

In terms of biomass production, concerns include the legal considerations surrounding how the DOT can generate revenue from the harvested crops, how to establish P3s to develop a biomass program, and how to set up ROW leasing or easement contracts with farmers or private companies.

Texas legislation allows public utility companies to locate their infrastructure in the ROW of state-owned highways. Therefore, public utility providers will be concerned about being liable for any damage to vegetation planted along the ROW and will seek priority over a biomass application. In fact, TxDOT as the lessee of ROW may be held responsible and liable for any damage to utilities that have been accommodated in TxDOT ROW as a result of mowing, planting, and harvesting crops. Hence, liability concerns will have to be clearly addressed in leasing agreements to avoid future disputes. Therefore, whenever a project involves a partnership with third parties, ODOT recommends the involvement of the DOT's General Counsel (and on occasion the Attorney General) to review any contracts with private parties to minimize any potential risks and undesired liability to the DOT.

3.10.2.4 Financial/Economic Feasibility

In the case of biomass production, significant economic benefits have been reported in terms of energy production—it is estimated that 30% of the liquid fuel demand in the U.S. could be supplied by biomass—and because the growing of crops can help rural development through job creation and enhanced business activities (SECO, 2008). Costs to consider in the financial analysis of biomass production include expenses associated with fertilizing, soil stabilization, watering, seeds, harvesting, and removal of existing vegetation to establish the crops. In regions with poor or dry soil, these factors will be critical in determining the viability of the program. According to UDOT, by selecting the appropriate crop seed and using some agronomical techniques, the need for water, fertilize, humus, and insecticide could be reduced by 80% compared to the planting of grass or flowers in ROW. The main objective of a biomass program is to substitute the vegetation the DOT already plants and/or mows with a revenue-generating crop that can add commercial value to the existing activity. In addition, biomass production requires only two costly activities per year—i.e., planting and harvesting—whereas some vegetation management programs require mowing more than two times in a year. It is also important to bear in mind that each crop has a different production capacity and cost-effectiveness that varies according to site characteristics. The price of the biofuel also affects the financial feasibility of a program. On the other hand, the use of appropriate vegetation or crops can reduce and solve maintenance and pest control problems. These additional benefits enhance the economic feasibility of this application while benefiting the environment (e.g., more green, less pesticides, and potentially less carbon emission from equipment). These variables and uncertainties, however, make the economic analysis complex and unique for each circumstance.

Regarding potential business models for biomass projects, various possibilities exist. The adoption of a specific business model will depend on the DOT's goal and the interest of the investor. It is important to bear in mind that the attractiveness and financial feasibility of the project may vary depending on the business model adopted. Following are the four main business models generally used for biomass programs:

- The DOT sows, cultivates, and harvests the biocrop feedstock and then pays a biorefinery to process and convert the feedstock into biofuel that the DOT uses in its own fleet. This model is being used by North Carolina DOT;
- The DOT sows, cultivates, and harvests the biocrop feedstock and then sells the feedstock to a private company (i.e., biofuel producer/vendor);
- The DOT issues a permit to nearby farmers—through a leasing agreement (i.e., rent fee payment)—allowing the farmers to sow, cultivate, and harvest the biocrop feedstock and then use the feedstock; and
- The DOT is responsible for performing all tasks (i.e., farming and refining). UDOT has been using this model in their pilot project with USU.

3.10.2.5 Environmental Considerations

Although biomass and biofuel production are not completely carbon-free sources of energy—GHG emissions are emitted during energy production—they are producing considerably less carbon compared to fossil fuels. Two major environmental issues associated with biofuels are the need for water for planting in some Texas regions and for energy production. Some perennial vegetation, such as switchgrass, does not require watering once established and can endure extremely hot weather. In addition, some drought-tolerant crops that can be used for biofuel production do not require any water. The use of fertilizer also raises some environmental concerns and imposes costs and is typically avoided. On the other hand, using highway ROW for biomass production can help to avoid the expansion of farming into environmentally sensitive areas—a common challenge found with conventional biofuel production. Moreover, biofuel is non-toxic to humans and animals, as well as biodegradable (i.e., disposal and waste are absorbed by the environment without being polluting).

3.10.2.6 Potential Social Impacts/Benefits

The biodfuels market has gained prominence worldwide due to increasing fossil fuel prices and pollution concerns. In Texas, the ethanol and biodiesel market is not as prominent partly because grain has mostly been produced for animal (mostly cattle) consumption. Concern has also been expressed that the planting of any crop for energy production can have a negative effect on food prices and thus be detrimental to society. For example, ethanol production has been cited as removing corn from the food market, resulting in an increase in the price of corn and corn products. In addition, land competition and crop substitution have raised the price of certain commodities. Using DOT ROW for biomass production can thus reduce the need for using farm land for energy crop production, thereby alleviating pressure on food and other commodity prices (SECO, 2008). It is also expected that forms of ethanol and biodiesel can be produced for less than petroleum-based fuels—if the price of crude oil per barrel remains at the 2008/2009 level. Finally, biorefineries have to be constructed close to where the feedstocks are produced, thereby requiring infrastructure investments such as roads, warehouses, and storage. These investments could generate temporary and permanent jobs in rural areas, and help to support rural and agricultural activities.

3.10.2.7 Safety Considerations

A good vegetation management strategy enhances road safety and prevents erosion. Vegetation along highway ROW defers erosion by reducing landslides, controlling invasive plant species, retaining storm water, and holding snow (i.e., living snow fence). Appropriate vegetation can also provide a natural barrier along coastal roads, along hills and valleys, and against animals, thereby reducing animal-vehicle collisions. In the UDOT pilot project, crops that do not attract animals were reportedly planted. Nonetheless, no studies have been undertaken to correlate animal attraction to the type of crop planted. On the other hand, the switchgrass planted in Tennessee could be a problem, because its high height could attract animals to use the switchgrass as “home” and for protection (Hank, 2011). In addition, tall grasses, such as switchgrass, can reduce the visibility and sight range of drivers, thereby increasing accident risk. Some concern has also been expressed by TxDOT that switchgrass can be invasive—therefore requiring frequent mowing—and cause erosion problems. TDOT acknowledged these concerns, but argued that plot selection could solve these issues—for example, by not planting on central ROW lands.

Woody vegetation (e.g., trees) can pose hazardous obstacles for drivers that run off the road. To overcome safety concerns, TDOT recommends a clearance (i.e., safety zone) of at least 30 feet from the road’s edge to the vegetation (i.e., trees and switchgrass). Another potential concern is the impact of agricultural activities—such as plowing, tilling, and harvesting by agricultural machines—and/or vegetation roots on underground utilities (e.g., gas lines, oil lines, electricity, telephone, water, and fiber optics) in the ROW. This simultaneous use of ROW by utilities and farming can potentially interrupt service to customers (Minnesota DOT, 2006). In the case of the UDOT pilot project, the crops will be planted in areas where some vegetation already exists and mowing activities are performed. Moreover, all equipment used for planting and harvesting crops would be similar to the equipment used to mow. Therefore, biomass production is not believed to present any risk to utilities. However, it was recommended to coordinate with utility companies if utilities are buried underground.

Safety is the primary concern of any DOT and, hence, the UDOT biofuel program is designed to be as safe as possible. Farmers and any person involved with the program are and will be trained on how to be safe along the roadside. A traffic control plan is also a requirement and has to be prepared prior to any activity taking place on the ROW. Also, because the equipment and activities involved in the biomass program resemble the equipment for mowing and the mowing process, all the safety concerns and precautions that are already used for mowing will apply.

3.10.2.8 Examples

In the case of biomass production, several DOTs have been conducting research and supporting pilot projects. UDOT, for example, launched a research project in 2006 in conjunction with USU to assess the feasibility of planting drought-tolerant crops such as canola, safflower, dwarf sunflower, camelina, gumweed, mustard, and perennial flax (see Figure 3.69) along the ROW in a non-irrigated environment (see Figures 3.70 and 3.71) (Wakil et al., 2007). This was the first project devoted to evaluating the feasibility of growing seed crops in highway ROW. The idea—as envisioned by the researchers—is to harvest enough seed to produce in-house biodiesel for UDOT's fleet, including the heavy diesel machinery and snow plows. In addition, the seed crops will render a more beautiful ROW and reduce roadside maintenance costs (e.g., mowing and pest control). It is estimated that a 100-foot-wide ROW with a 66% dry land yield could potentially produce more than 500 gallons of biodiesel per mile of land, using agronomic methods and equipment (Wakil et al., 2007).

Source: Wakil et al., (2007)

Figure 3.69: Seed Crops Used in Utah Pilot Project

Source: Wakil et al. (2007)

Figure 3.70: Utah Pilot Project Plot

Source: Wakil et al. (2007)

Figure 3.71: Mowing the Highway ROW for Utah Pilot Project

The USU researchers listed the following potential benefits and advantages of biofuel production in highway ROW:

- increased aesthetics of the roadside,
- reduced maintenance costs,

- advertising for and public education on renewable fuel,
- sustainability, and environmental issues,
- no negative effect on food supply, and
- all the associated benefits of biofuels.

The USU researchers are also assessing potential impacts such as safety, structural integrity of the road and shoulders, establishment and harvesting of the crops, economic viability, wildlife impacts, ecology/environmental impacts, water quality, and grower concerns (Wakil et al., 2007). In summary, USU researchers assert that the feasibility of biomass projects should be assessed according to the following criteria: crop type, erosion, structural integrity, habitat issues, sight clearness, risk management, ecological impacts, and water concerns (Volpe Center, 2011).

Similarly, the North Carolina DOT (NCDOT) initiated in 2009 its biomass and biofuel project. Currently, NCDOT's project is recognized as one of the most successful biomass projects in the U.S., largely because of the state's moist climate, fertile soil, and support from the state legislature. The project started with four 1-acre plots of canola or sunflower crops. These crops were selected by NCDOT, in conjunction with North Carolina State University, because of their estimated greater potential yield in the ROW scenario. NCDOT has been experimenting with seasonally rotated crops on the same plot, thereby meeting or exceeding national standards for crop production (Volpe Center, 2011).

Genera Energy LCC—a for-profit limited liability company wholly owned by the University of Tennessee Research Foundation—is also conducting a pilot project in partnership with TDOT. The objective of the pilot project is to verify if switchgrass—one of the primary feedstocks used to produce cellulosic ethanol and native to all American states—planted along the highway ROW can yield reduced maintenance costs (due to less mowing activities and erosion along the roadside) as well as generate revenue from biomass for biofuel production (Burke, 2010). Switchgrass was chosen because it is "a native plant that can reach a height of 10 feet" (see Figures 3.72–3.74) and yield high tonnage for ethanol production per acre, thereby replacing corn as the primary feedstock for ethanol. TDOT stated that "we won't mow it for biofuel…it's going to be for erosion and hopefully save us some money on mowing." Erosion protection is due to the long and very distributive roots of the switchgrass that can reach 8–9 feet in the soil. In addition, the root characteristics contribute to better water absorption by the soil—mainly in the case of compact soil—which helps prevent or defer soil erosion as well.

In terms of cost, it is estimated that a pound of switchgrass costs about $20 to plant and get established. TDOT asserts that the ideal location will be where the current cost of mowing is lower, because mowing cost is usually correlated with better access, less traffic disruption, less safety concerns, and effective support (i.e., infrastructure). Although TDOT seeks only cost savings as a benefit, the agency acknowledges and envisions carbon credits and biofuel production as potential revenue streams. Furthermore, locating plots near each other will also reduce the cost of planting, mowing, and hauling the switchgrass. Another consideration involves the plot characteristics. Because of the cost of planting and harvesting, the minimum plot area should be greater than one acre and at least 300 feet wide. TDOT anticipates that some state law will likely preclude widespread application, mainly regarding the direct sale of the switchgrass by the agency. Therefore, farmers will be involved. Another potential legal issue involves environmental permits to use federal land for farming and agricultural activities.

CDOT and Ohio DOT have worked with local consulting companies and/or universities to identify opportunity zones and sites suitable for renewable energy and revenue generating projects on highway ROW. The identification has been made by overlaying ROW maps and GIS data layers of potential renewable energy sources (i.e., solar, wind, and biomass resource maps). Michigan DOT has identified 10,000 ROW acres suitable for biomass planting and it plans to announce a request for proposals soon (Volpe Center, 2011).

In Texas, TxDOT is exploring leasing highway ROW to farmers during the grass period, so additional grass can be harvested and gathered for feeding cattle and other animals during the dry season.

Source: Marin (2008)

Figure 3.72: Switchgrass

Source: Energy Insight (2007)

Figure 3.73: Bales of Switchgrass

Source: ScienceDaily (2008)

Figure 3.74: Plot of Switchgrass

3.10.2.9 Concluding Remarks

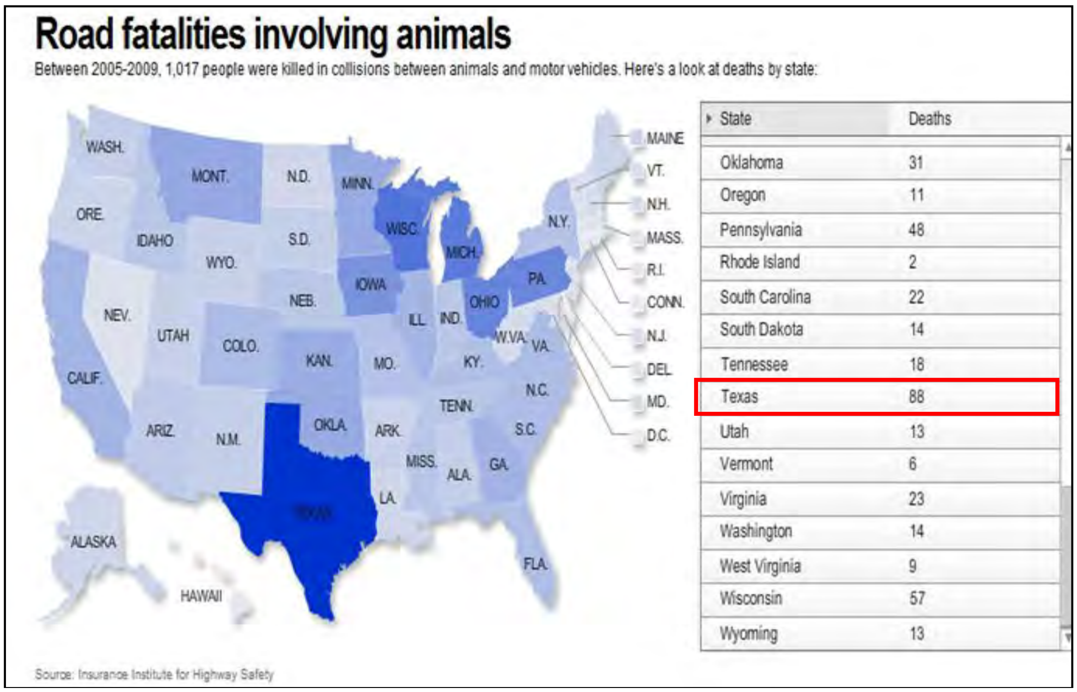
In the case of the biomass VEA, the main considerations are the following:

a. the requirement for a minimum 16 inches of rainfall and a regional climate (e.g., humidity and temperature) conducive to biomass production;
b. the site's location and characteristics (e.g., width, access, area, slope and soil characteristics);
c. safety and logistic considerations (e.g., clear zone, potential to attract animals, distance from refineries, and size of harvesting machines);
d. long-term commitment and an assessment of required future expansions;
e. potential interference with utility companies and ROW access;
f. upper-management support and an in-house champion, who would be responsible for leading and conducting the entire implementation process;
g. permits (i.e., utility accommodation, airspace lease, special use permit, and easement) and legal considerations regarding RECs, incentives, and patents;
h. potential conflicts with Texas's Highway Beautification Act and Wildflower program;
i. appropriate business model, contractual agreements, liabilities, and responsibilities (e.g., site security, maintenance, termination conditions) and the importance of shared risk agreements;

j. involvement of the State DOJ as well as legal counsel to advise and review the written agreements with private parties and minimize any potential risks and undesired liability to the DOT; and
k. need for effective public involvement and securing public support

3.11 Wildlife Crossings

Accidents involving animals are a concern worldwide. In October 2010, TxDOT issued a warning to drivers about deer during the fall season. TxDOT estimated that in 2009, more than 7,000 animal-related crashes occurred on Texas highways, of which 25 entailed a fatality (TxDOT, 2010). Furthermore, since 1996, Texas has been the state with the highest number of fatalities from animal-vehicle crashes (Deer Crash Website). Figure 3.75 presents nationwide statistics on road fatalities involving animals.



Source: USAToday (2010)

Figure 3.75: U.S. Statistics on Road Fatalities Involving Animals

Approximately 300,000 accidents involving cars and large animals occur annually in the U.S. Furthermore, if unreported collisions with animals are included, the number is likely to reach one to two million incidents. Nearly 26,000 animal-vehicle crashes cause human injury and 200 results in a human fatality (FHWA, 2008). These statistics do not consider the number of animals killed. An FHWA study "identified 21 federally listed threatened or endangered animal species in the U. S. for which road mortality was documented as a major threat to their survival" (FHWA, 2008). Most studies that researched wildlife collisions and the types of roadways also found that most of the wildlife-vehicle collisions have occurred in rural areas (FHWA, 2008).

Source: Quinn (2008)

Figure 3.76: Wildlife Fence

Source: Quinn (2008)

Figure 3.77: Wildlife Barrier

Source: Quinn (2008)

Figure 3.78: Wildlife Sign

Several measures exist to mitigate wildlife-vehicle collisions and preserve species, such as signs, fencing, barriers, vegetation removal, and animal detection systems (see Figures 3.76, 3.77, and 3.78). Nonetheless, "wildlife crossings have been the most successful at reducing both habitat fragmentation and wildlife-vehicle collisions caused by roads" (Clevenger, 2006). Therefore, strategically located wildlife crossings have the potential to not only reduce fatalities, but also preserve animal life and endangered species. Wildlife crossings are defined as structural passages under or over roadways that enable animals to safely move across roadways. Examples include structures (viaducts), valleys, ridgelines, and game trails. Wildlife crossings are regarded essential to habitat conservation because they combat habitat fragmentation caused by roadways by allowing a connection or re-connection between habitats (Clevenger, 2006).

3.11.1 Technical Feasibility

The effectiveness and efficiency of wildlife crossing structures are largely a function of the location, type, and dimensions of the crossings and, hence, are site specific. The attributes of wildlife crossings thus have to be carefully studied and planned to accommodate the species targeted and the surrounding landscape (FHWA, 2008). Existing information about wildlife movement and occurrence in the project area (e.g., road-kill data, maintenance reports, and DOT, agency, university, and non-governmental organization studies) have to be critically reviewed before selecting the type and location of specific wildlife crossings (Quinn, 2008). Given a lack of information to inform a decision, a field survey should be conducted. Furthermore, some researchers have found that arched structures may reduce the effectiveness of the crossing, because the arc shape hinders the animal's visibility, preventing it from seeing the other side of the road before climbing up it to cross (MountainNature.com, 2005). In addition, the type of crossing (i.e., overpass and underpass) preferred by different animals varies. Research conducted in 1996 on the crossing structures in the Banff National Park determined that underpass structures were "very effective for elk, deer, and coyotes," while large carnivores (e.g., wolves, cougars, and black and grizzly bears) were "reluctant to use them." However, more recently it has been shown that animals can adapt and start to use underpass crossings (MountainNature.com, 2005).

The design of the wildlife crossing structure is arguably the most important consideration, because it not only influences the cost but it also determines the effectiveness of the crossing. Therefore, it is essential that the following basic elements be incorporated into the design. First, the appearance of the structure should be natural and, thus, fit into the surrounding area. The vegetation approaching the structure has to be similar to the adjacent habitat and the soil on the "floor" of the structure has to be the same as if the structure was not there. This will instill more comfort and confidence in the animal to use it. Moreover, the wildlife crossing should be located on the animal's natural migration route, i.e., where they naturally approach the road or where they are historically found. Location is one of the paramount factors in determining the success of the wildlife crossing. Second, discordant elements, such as bright metal signs and construction materials, should be avoided near the approach areas, because they reduce the effectiveness of the wildlife crossing. Also, fencing is critical to the success of the wildlife crossing, because it forces and trains animals to use the structure. Third, it is important that the crossing structure provides a clear line of sight, i.e., the animal is able to see the other side of the road (Carnivore Safe Passage, 2007).

As mentioned before, the design of wildlife crossing structures is arguably the most important aspect and determinant of the success of the structure. However, the construction of the structure can impose some challenges and hinder the feasibility of this VEA, especially when a crossing is implemented over or under an existing road. A number of construction techniques and structural solutions must be considered and evaluated during the initial planning and design phases. Traffic control or detours may also be required. Some solutions, such as large underpasses, may be very disruptive and very expensive. On new highway projects, most obstacles can be easily overcome if wildlife crossings are incorporated early on in the planning phases of the new project.

3.11.2 Political/Public Concerns

The implementation of wildlife crossing structures has received substantial support from the U.S. Congress. For example, the Transportation Equity Act TEA-21 guaranteed the availability of federal funds for wildlife crossing structures on existing roads, as well as new road projects (Hartmann, 2001). In addition, the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) (Public Law 109-59) "directed the Secretary of Transportation to conduct a national wildlife-vehicle collision study" (FHWA, 2008). These bills provide evidence of political concern for the road users' safety and environmental preservation.

Concurrently, the Humane Society of the U.S. has pointed to the impacts imposed on wildlife by roads and reported and supported initiatives that aim to mitigate wildlife-vehicle collisions and reduce road kill. Wildlife preservation has been debated and discussed among governments and organizations worldwide. All new road projects are required to have an environmental impact study and mitigation strategy for fauna and flora. Therefore, measures for engaging the public, communities, and various organizations, as well as for sharing a DOT's efforts and attitudes toward the environment and wildlife preservation, can be fundamental to reduce public controversy and outcry against projects (see Figure 3.79) (Quinn, 2008). Several ways exist to share information, including brochures, e-mails, mail, billboards, and signs (see Figure 3.80).

Source: Quinn (2008)

Figure 3.79: Public Outcry

Source: Quinn (2008)

Figure 3.80: Educational Billboard and Program

3.11.3 Legal Considerations

Environmental protection and traffic safety have been intensively discussed by lawmakers and governments. Several regulations and entities have been created and established nationwide and statewide to determine the impacts of infrastructure projects on the environment and road users. In the case of highway projects, the following regulations and entities pertain to the implementation of wildlife crossings: NEPA, the Ecological Society of America (ESA), and SAFETEA-LU at the national level, and the Texas Commission on Environmental Act (TXEA) at the state level. An example of how the courts can interpret the law occurred in 2003 when the Arizona Court of Appeals ruled in favor of a motorist that collided with a road-killed elk on Interstate 40 (Ecostudies Institute, 2005). The court awarded $3.1 million to the plaintiff. Although other courts have ruled differently on the liability of states for animal-vehicle crashes, the decision of the Arizona Court of Appeals has provided a precedent and has highlighted the need for and importance of wildlife crossings.

3.11.4 Financial/Economic Feasibility

The cost of a wildlife crossing structure is determined by the type of crossing (i.e., underpasses or overpasses) and if it will be built on an existing road or as part of a new highway project. In general, the overall cost of overpass structures is higher than underpasses. For example, an overpass that is being proposed on Montana Highway 83 (two-lane road) is estimated to cost between $1.5 and $2.4 million (FHWA, 2008). However, the benefits generated by wildlife crossings seem to outweigh the construction and maintenance cost of the structure.

Table 3.8 summarizes the potential funding sources that have been included in SAFETEA-LU for the construction of wildlife crossings.

Table 3.8: SAFETEA-LU Funding Sources

Source: FHWA (2008)

Funding Source	Amount (2005-2009)	Notes
Highway Safety Improvement Program (HSIP)	$5.1 billion	This program has $90 million set aside each year for high-risk rural roads (wildlife-vehicle-collisions (WVC) are commonly a rural challenge). To be eligible for these funds, WVC mitigation projects need to be part of a state's Strategic Highway Safety Plan.
Bridge	$21.6 billion	Bridge projects can provide an opportunity, with limited wildlife exclusion fencing and a limited extension to the length of a bridge, to funnel wildlife under the bridge, removing the hazard from the roadway.
Interstate Maintenance, Surface Transportation, National Highway Programs.	$25.2 billion $32.5 billion $30.5 billion	Incorporate WVC mitigations within reconstruction and maintenance projects that are funded by these programs.
Planning, Environment, and Realty (HEP) Programs	Numerous sources	Other federal transportation resources for WVC mitigation can be found in U.S. DOT agencies and programs. A list of programs funding environmental activities is on the U.S. DOT website at http://www.fhwa.dot.gov/hep/index.htm (accessed 6 June 2008).
Public Lands Highways Discretionary Program	In 2006, 77 projects designated to receive $95.2 million	This program is authorized to fund projects on an annual basis in 11 western states that contain at least 3% of the total public land in the U.S. See website at http://www.fhwa.dot.gov/discretionary/ (accessed 6 June 2008).
Surface Transportation Environment and Planning Cooperative Research Program (STEP)	$67.5 million	STEP is the sole source of funds for all FHWA research on planning and environmental issues. One environmental emphasis area called Natural Environment includes wildlife habitat. The FHWA will provide ongoing opportunities for funding collaborative research. See website at http://www.fhwa.dot.gov/hep/step/step.htm (accessed 6 June 2008).

Funding Source	Amount (2005-2009)	Notes
Technology Deployment Program	$4.1 million	Administered by the FHWA, this program includes the Innovative Bridge Research and Deployment Program, which is intended to promote, demonstrate, evaluate, and document innovative designs, materials, and construction methods for bridges and other highway structures.
Transportation Enhancement Program (TEP)	Part of the Surface Transporta-tion Program	TEP funds transportation-related projects designed to strengthen the cultural, aesthetic, and environmental aspects of the U.S. intermodal transportation system, offering communities additional non-traditional transportation choices. See website at http://www.fhwa.dot.gov/environment/te/ (accessed 6 June 2008).
Federal Lands Highway Program (FLHP)	$893 million	The primary purpose is to provide funding for a coordinated program of public roads to serve the transportation needs of federal lands that are not a state or local government responsibility. This program contains five categories: Indian Reservation Roads, Park Roads and Parkways, Forest Highways, Public Lands Highways, and Refuge Roads. The FLHP roads serve recreational travel and tourism, protect and enhance natural resources, provide sustained economic development in rural areas, and provide needed transportation access for Native Americans. See website at http://www.fhwa.dot.gov/flh/flhprog.htm (accessed 6 June 2008).
Coordinated Federal Lands Highway Technology Implementation Program (CTIP)	Numerous Sources	This is a cooperative technology deployment and sharing program between the FHWA Federal Lands Highway office and federal land management agencies. It provides a forum for identifying, studying, documenting, and transferring new technology to the transportation community. Many new innovative technologies, such as measures allowing fish passage through culverts, have been funded through the CTIP program. CTIP funds are normally used for technology projects related to transportation networks on federal public lands. Research projects are not eligible under this program. See website at http://www.fhwa.dot.gov/flh/ctip.htm (accessed 6 June 2008).
Federal Transit Administration	$45.3 billion	This has a grant program for funding transit-related planning and other projects. See web site at http://www. fta. dot.gov/grants_financing.html (accessed 6 June 2008).
State and Community Highway Safety Program	Variable	Administered by the National Highway Traffic Safety Administration, this program provides grants for the states, federally recognized Indian tribes, the District of Columbia, Puerto Rico, American Samoa, Guam, Northern Marianas, and the Virgin Islands. See website at http://www. federalgrantswire.com/state_and_community_highway_safety.html (accessed 6 June 2008).

In addition to the listed federal funding sources in Table 3.9, other federal programs can also grant funding for wildlife crossings, such as the U.S. Fish and Wildlife Service (FWS), Natural Resource Assistance Grant Programs, and Cooperative Endangered Species Conservation Fund. Furthermore, wildlife-vehicle collision mitigation programs can be eligible for funding from private foundations, such as the National Fish and Wildlife Foundation and National Park Foundation, as well as corporate philanthropies, such as the National Directory of Corporate Giving and Fundsnet Services Online. Finally, local tax measures were approved in Arizona to fund wildlife crossing structures (FHWA—Chapter 7).

The Western Transportation Institute conducted research to assess wildlife-vehicle collision costs in terms of the following parameters: property damage (e.g., vehicle repair cost), human injuries, human fatalities, towing expenses, accident attendance and investigation, the monetary value of the animal involved, and disposal cost of the animal carcass (FHWA, 2008). Table 3.9 summarizes the estimated cost of colliding with the three most common animals involved in accidents (i.e., deer, elk, and moose).

Table 3.9: Estimated Cost of Wildlife-Vehicle Crash

Source: FHWA (2008)

Description	**Deer**	**Elk**	**Moose**
Vehicle repair costs per collision	$1,840	$3,000	$4,000
Human injuries per collision	$2,702	$5,403	$10,807
Human fatalities per collision	$1,671	$6,683	$13,366
Towing, accident attendance and investigation	$125	$375	$500
Monetary value animal per collision	$2,000	$3,000	$2,000
Carcass removal and disposal per collision	$50	$100	$100
Total	$8,388	$18,561	$30,773

Table 3.9 demonstrates that collisions involving deer alone—which is the majority of the collisions in the U.S. at approximately one million per year—cost $8.39 billion annually to users, insurance companies, and the government (FHWA, 2008). In addition, the Insurance Institute for Highway Safety reported that more than 1.5 million deer-car crashes occurred in the U.S. in 2009, resulting in $1.1 billion in estimated vehicle damage alone (TxDOT, 2010).

The Virginia Transportation Research Council examined two underpasses in Virginia from June 1, 2004, to May 31, 2005, to assess their cost-effectiveness. Donaldson (2005) concluded that the least expensive underpass—i.e., $250,000 in construction costs—would re-pay its investment cost with the prevention of only three deer-vehicle collisions per year, whereas the more expensive underpass—$590,000 in construction costs—would require the prevention of nine deer-vehicle collisions per year to re-pay its investment cost. In this cost-effectiveness analysis, only the costs to property damage were included. The true cost of each collision is much higher if insurance cost, "cost associated with human injury or death, cost of lost productivity, the economic value of the animal, and the cost of cleaning up the accident and removing the animal carcass" are considered (Ecostudies Institute, 2005).

Several mitigation methods for wildlife vehicle collisions have been reported upon in in a 2008 FHWA-sponsored study. Table 3.10 summarizes the mitigation methods analyzed and evaluated in the study. Table 3.10 makes evident that crossing structures (i.e., underpasses and overpasses) have the highest net "benefit minus cost" balance in preventing animal-vehicle collisions.

Table 3.10: Cost-benefit of Mitigation Measures

Source: FHWA (2008)

Mitigation Measure	Cost ($/km/yr)	% DVC Reduction	Benefit ($/km/yr)	Balance ($/km/yr)
Standard warning signs	$18	0%	$0	-$18
Enhanced wildlife warning signs	$249	?	?	?
Seasonal wildlife warning signs	$27	26%	$10,904	$10,878
Animal detection systems (ADS)	$31,300	82%	$34,391	$3,091
ADS linked to on-board computer	?*	82%	$34,391	?
On-board animal detectors	$2,225*	?	?	?
Vegetation removal	$500	38%	$15,937	$15,437
Deer reflectors and mirrors	$495	0%	$0	-$495
Deer whistles	$23.5*	0%	$0	?
Carcass removal	$250*	?	?	?
Population culling	$2,508	50%	$20,970	$18,462
Relocation	$10,260	50%	$20,970	$10,710
Anti-fertility treatment	$61,702	50%	$20,970	-$40,732
Fence (including dig barrier)	$3,760	87%	$36,488	$32,728
Boulders in right of way	$2,461	?	?	?
Long bridges	$781,250	100%	$41,940	-$739,310
Long tunnels or long bridges	$1,500,000	100%	$41,940	-$1,458,060
Fence with gap and warning signs	$3,772	0%	$0	-$3,772
Fence with gap and crosswalk	$5,585	40%	$16,776	$11,191
Fence with gap and ADS	$9,930	82%	$34,391	$24,461
Fence with underpasses	$5,860	87%	$36,488	$30,628
Fence with overpasses	$26,485	87%	$36,488	$10,003
Fence with under- and overpasses	$7,510	87%	$36,488	$28,978

Assumes 1 km with 5 DVCs per year
* Costs not in dollars/km/year, but in a different unit; see text.
? = Unknown or uncertain.

3.11.5 Environmental Considerations

Highways and roads have the "most widespread and detrimental impacts" (Spellerberg, 1998) and are threatening endangered species and animal habitats as follows:

- roads reduce the quality and amount of habitat,
- roads increase animal mortality due to animal-vehicle collisions (i.e., road kill),
- roads divide habitat, preventing animals on one side to access resources on the other side and vice-versa, and
- roads segregate wildlife populations into smaller groups, making the groups more vulnerable.

In summary, habitat fragmentation can entail extinction or extirpation of particular species. Therefore, constructing wildlife crossings can be fundamental in minimizing the impacts of roads on the environment. Wildlife crossings can thus integrate habitats, reduce animal mortality, and help to save endangered species.

3.11.6 Potential Social Impacts/Benefits

A major social benefit of wildlife crossing structures is that they can reduce animal vehicle collisions, thereby helping to preserve human life and assets, as well as reduce government and personal expenditures by spending less money on road maintenance (e.g., removing animal carcasses, investigating and reporting accidents, etc.), the government can direct the “savings” to other social priorities. Finally, the construction of crossing structures may entail job creation.

3.11.7 Safety Considerations

According to the 2008 FHWA study, wildlife-vehicle collisions “are less severe than other crashes” and in general almost all animal-vehicle collisions “resulted in no human injury (95.4%)” (FHWA, 2008). Nonetheless, animal-vehicle collisions do result in a number of human fatalities. Figure 3.81 illustrates the severity distribution of vehicle collisions with animals. In addition, several studies have demonstrated that a well-designed wildlife crossing can effectively enhance roadway safety and diminish the number of animal-vehicle accidents. The sole safety concern that may arise whenever a wildlife crossing is planned involves the construction of crossing structures on existing roads. As previously mentioned, some precautions are necessary to ensure safety, such as detours, traffic controls, and a constructability study.

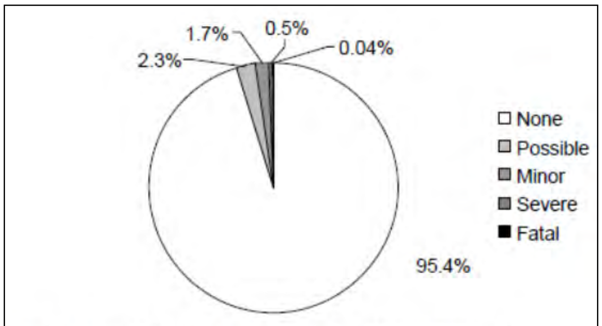


Figure 9. Graph. Severity distribution for AVCs (GES data).

Source: FHWA (2008)

Figure 3.81: Severity Distribution of Animal-Vehicle Collision

3.11.8 Examples

Wildlife overpasses are very common in Europe. In North America, however, there are only six examples of these structures, of which two are located in the Banff National Park in Alberta, Canada. Tunnels (i.e., underpasses) have, however, been more widely implemented in the U.S.

The Banff National Park and Trans-Canada Highway (in Alberta, Canada) have perhaps the “most recognizable wildlife crossings in the world” (Clevenger, 2006). Banff National Park has 22 underpasses and 2 overpasses[7] (see Figures 3.82 and 3.83) that have been monitored and studied for more than 25 years. These studies have found that 10 species of large mammals have used the 24 crossings more than 84,000 times. Furthermore, fencing to guide animals to these crossings has reduced the number of large ungulates’ mortality by more than 80%. Because of

[7] The two overpasses were constructed in 1997 at a cost of approximately $1.851 million (MountainNature.com).

the documented benefits of the current wildlife crossings and in an effort to increase driver safety, Parks Canada is planning to build 17 new crossing structures across the Trans-Canada Highway (Clevenger, 2007).

Source: FHWA (2008)

Figure 3.82: Wildlife Overpass in Banff National Park

Source: Quinn (2008)

Figure 3.83: Underpass Crossing

Along 40 miles of Interstate 75 (Collier and Lee Counties, Florida) are 24 highway underpasses (see Figure 3.84 and 3.85) and 12 bridges that were modified to allow for wildlife crossings along 40 miles. These crossing structures are "specifically designed to target and protect the endangered Florida panther" (Scott, 2007). The Florida Fish and Wildlife Conservation Commission reported that no panther has been killed in areas with wildlife crossings and fencing; therefore, the state intends to build many more crossing structures.

Source: FHWA (2008)

Figure 3.84: Southern Florida Underpass for Wildlife

Figure 3.85: Underpass Crossing

Finally, the Hoge Veluwe National Park in the Netherlands has three wildlife overpasses (called ecoducts) across Highway A50. It is estimated that in 1 year almost 5,000 deer and wild bears used at least one of the crossing structures (Danby, 2004). Figure 3.86 presents computer-generated illustrations of an overpass crossing.

Source: Quinn (2008)

Figure 3.86: Overpass Crossing Illustration

3.11.9 Concluding Remarks

Wildlife crossings have gained attention and consideration on several highways. Despite the safety and environmental benefits, the following must be considered when assessing the feasibility of this VEA:

a. the location and design of the wildlife crossing structure often determines the effectiveness of the project;
b. wildlife migration routes must be studied to determine the most effective location;
c. a number of federal funding programs exist to finance wildlife crossing projects;
d. underpass and overpass structures are the most cost-effective in mitigating and reducing vehicle-animal accidents; and
e. the construction of wildlife crossings on existing roads requires some safety considerations.

Chapter 4. Value Extraction Application Methodological Framework

This chapter explains the methodological framework that was developed to guide TxDOT in identifying and selecting the most appropriate Value Extraction Applications (VEAs) for implementation. The chapter concludes with remarks and general recommendations regarding the methodological framework and decision making process.

4.1 Methodological Framework

This section explains the methodological framework (see Figure 4.1) that was developed to provide TxDOT with step-by-step guidance when evaluating and selecting the most suitable VEA—given the agency's land asset and objective—for implementation, as well as when identifying and involving key stakeholders. The methodological framework is based on the information and findings collected during the research project. Each of the steps (see Figure 4.1) is sequentially discussed in this section. An explanation of the function and importance of each step is provided. Important information pertaining either to the decision step or methodological framework is also introduced where appropriate. Finally, an example (a hypothetical 30 acres of vacant land owned by TxDOT in a residential neighborhood) is used to illustrate how to use the methodological framework. The example depicts each step of the methodological framework by simulating the identification and assessment process of potential VEAs—given a specific scenario—and key stakeholders.

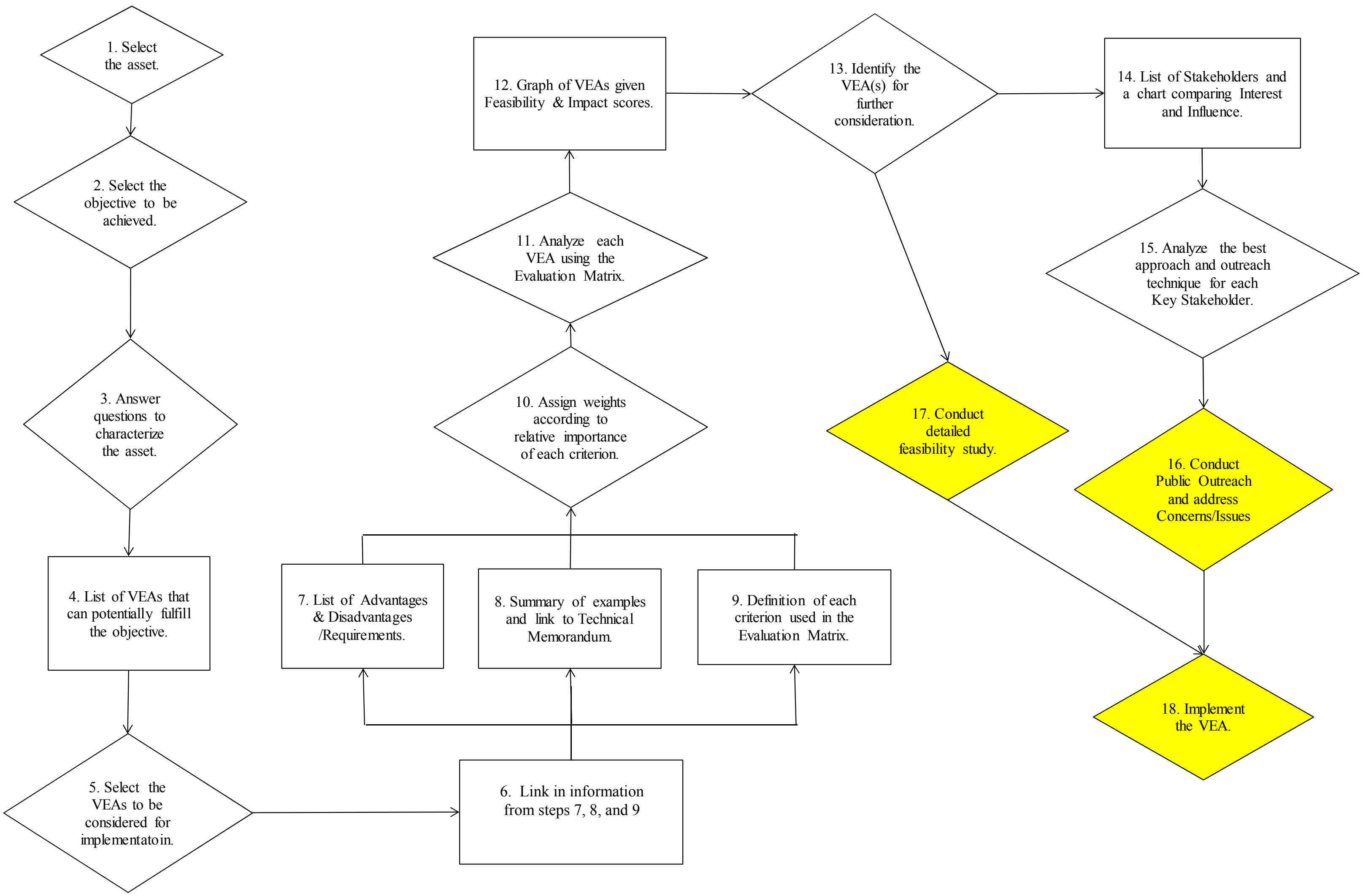


Figure 4.1: VEA Methodological Framework

Select Type of Asset (Step 1) and Specify Objective (Step 2)

The first step in the methodological framework is selecting the type of asset and the objective to be achieved. Not all 11 VEAs will be feasible for all types of TxDOT assets, which comprise vacant lands, ROW, office and facility buildings, and rest areas (see Figure 4.2). At the same time, not all 11 VEAs can potentially meet TxDOT's three objectives: save costs, increase revenue streams, and enhance societal goals (see Figure 4.3). Therefore, by specifying the type of asset and intended objective, TxDOT can start to filter and reduce the number of potential VEAs considered. Figure 4.4 to Figure 4.7 illustrate all the potential VEAs initially considered given the type of asset and intended objective. For the hypothetical case, vacant land is the type of asset (see Figure 4.2) and "increase revenue streams" is selected as the objective (see Figure 4.3). It is worth noting that although some VEAs can potentially achieve more than one objective, this framework requires the specification of one primary objective.

VEA Framework

- What is the property or asset?
  - ROW
  - Vacant Land
  - Office or Facility (Building)
  - Rest Area

Figure 4.2: Select the Asset Type

VEA Framework

- What is the intended goal/Objective?
  - Save Costs
  - Increase Revenue Streams
  - Enhance Societal Goals

Figure 4.3: Select the Objective

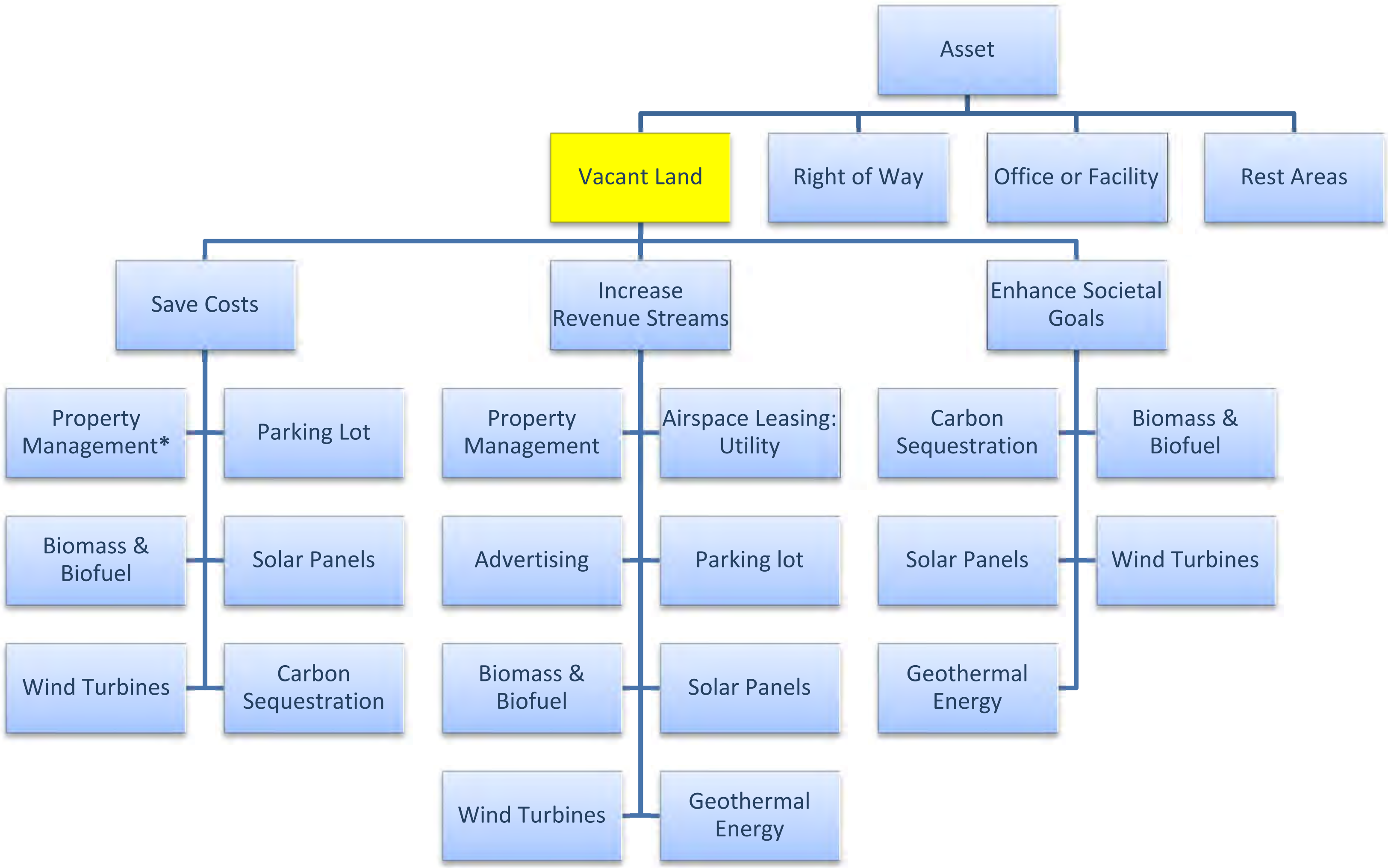


Figure 4.4: List of Potential VEAs for Vacant Land

*The property management application may entail one of three options: selling the property, leasing the property, or bartering the property.

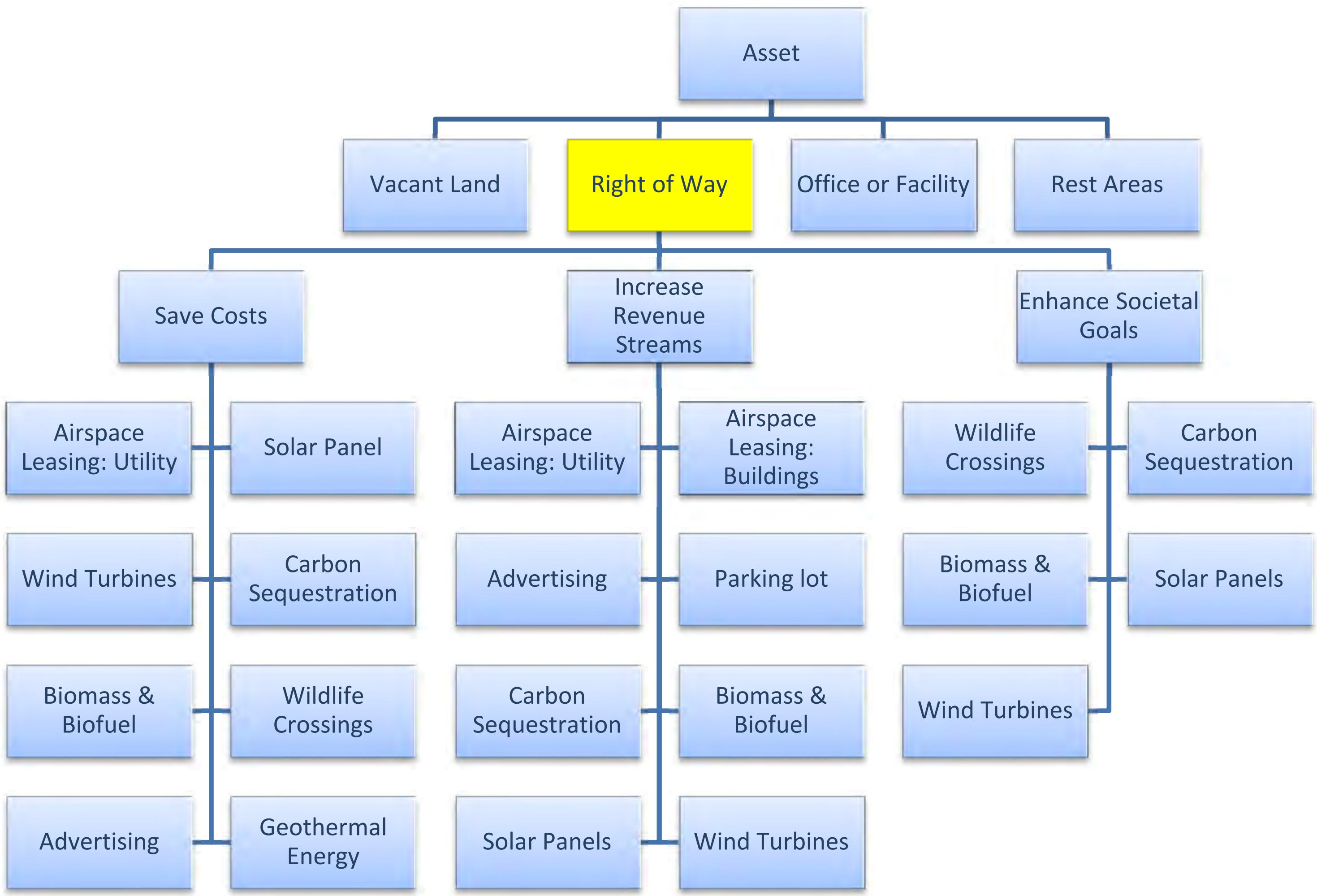


Figure 4.5: List of potential VEAs for ROW

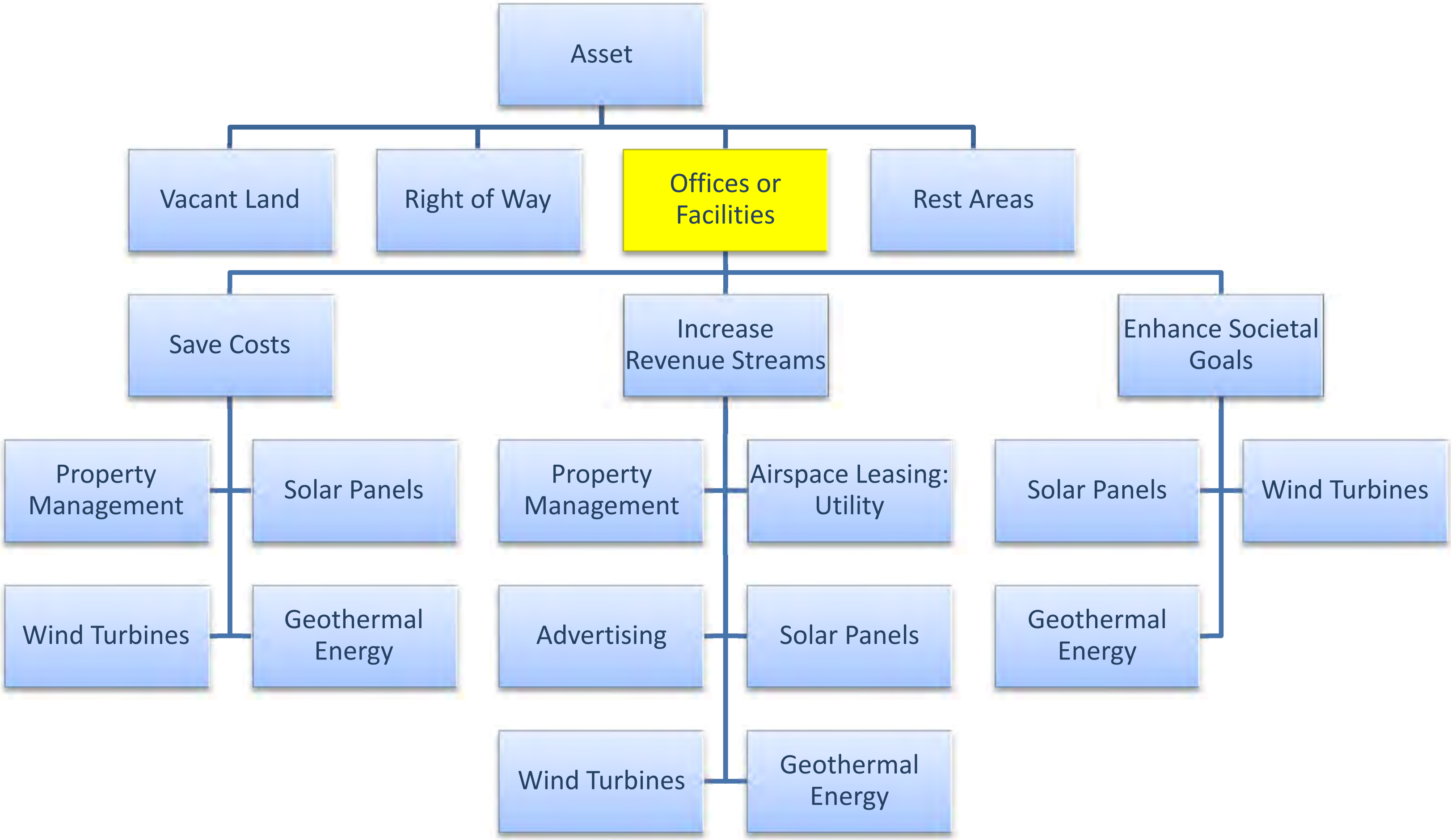


Figure 4.6: List of potential VEAs for offices and facilities

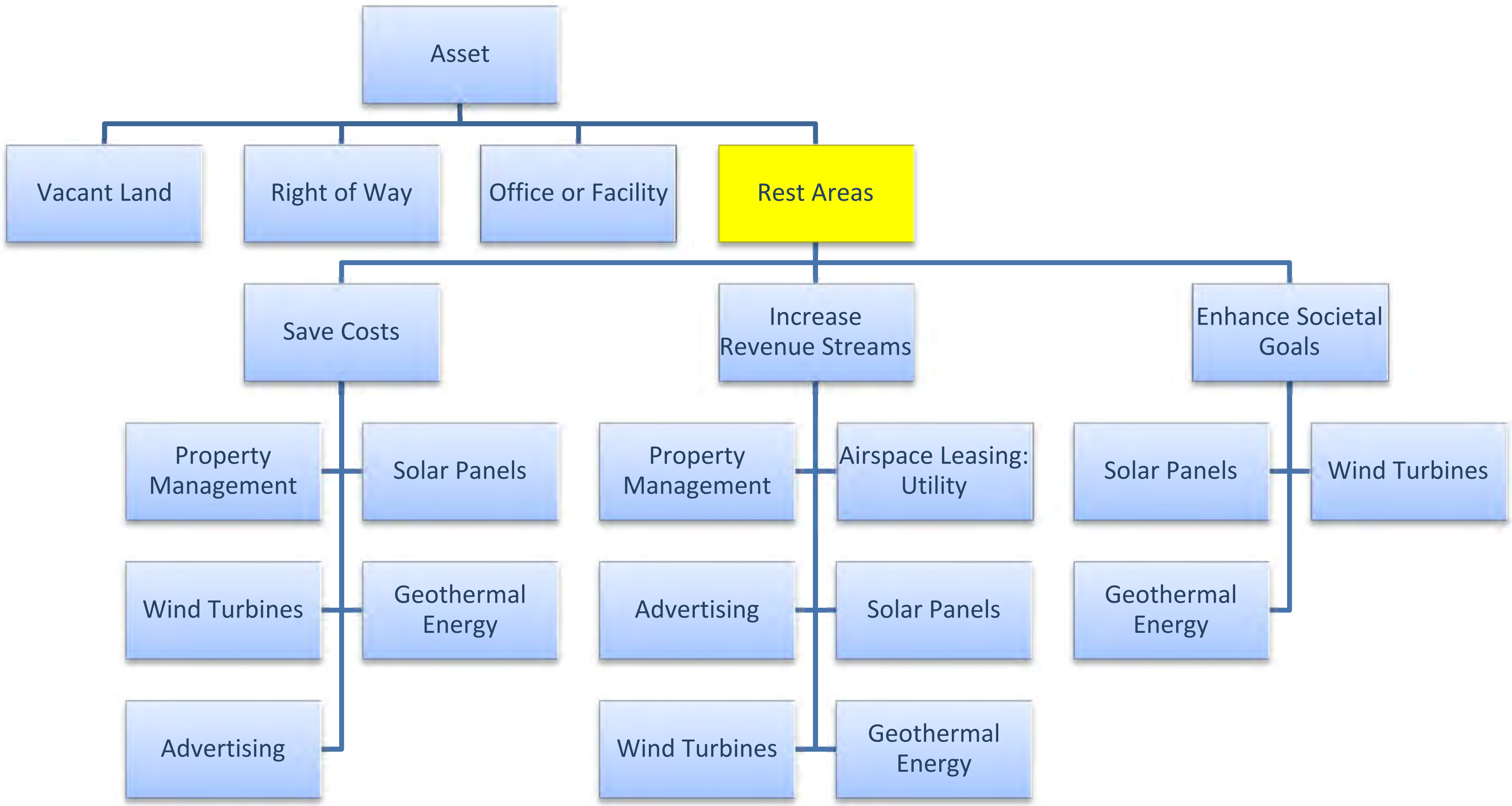


Figure 4.7: List of potential VEAs for Rest Areas

Answer Questions to Characterize the Asset (Step 3)

In addition to the type of asset it is also important to consider the characteristics of the asset as it impacts the feasibility of specific VEAs. Therefore, the next step in the methodological framework is to characterize the asset considered. To do so, questions are provided for the different type of assets (see Figure 4.8 and Appendix II). The questions address aspects that can prevent/impede the implementation of a VEA and/or can preclude a VEA from achieving the stated objective. The questions relate to the location of the asset (e.g., urban center), surrounding environment (e.g., distance to transmission lines and wetlands), climate and weather of the area (e.g., rainfall, and solar and wind energy potential), current use, timeframe to use property, and size of the property. These questions are intended to be a second filter of the potential VEAs, thereby reducing the number of alternatives further. Appendix III explains how the questions affect and filter potential VEAs. Figure 4.8 shows the questions for vacant land and the answers for the hypothetical example that is provided. Similar questions for the other three types of assets (i.e., ROW, office and facilities, and rest areas) can be found in Appendix II.

VEA Framework

- What are the characteristics of the vacant land?

1	Is the property in a prime real estate location?	~~Yes~~		No
2	Is the property in an urban center or commercial area or near a community center?	Yes		~~No~~
3	Is the property adjacent to or near a residential or commercial area?	~~Yes~~		No
4	Does the property have good easy access (or can access be secured)?	~~Yes~~		No
5	When will the property be developed (i.e., in how many years)?	< 5 yrs	5 yrs > < 20 yrs	~~> = 20 yrs~~
6	Is the property exposed to high traffic volumes?	Yes		~~No~~
7	How large (acres) is the property?	< 5 Acres		~~>= 5 Acres~~
8	Is the property on a flat terrain (or on a terrain with slope less than 20%)?	~~Yes~~		No
9	Does the property have good sun exposure (i.e., no sunlight obstruction)?	~~Yes~~		No
10	How far (miles) is the nearest a transmission line or electricity user/customer to the property?	~~< 1 mile~~		> = 1 mile
11	Is the property in a Competitive Renewable Energy Zone?	Yes		~~No~~
12	Is the property free of any wind obstructions (e.g., buildings, mountains, and hills)?	~~Yes~~		No
13	Is the property being mowed?	~~Yes~~		No
14	Can mowing of the property be halted?	Yes		~~No~~
15	What is the predominant vegetation on the property?	~~Grass~~	None	Tree
16	What is the average rainfall at the property?	< 15 in		~~> = 15 in~~
17	How far (miles) is the nearest biorefinery to the property?	= < 50 miles		~~> 50 miles~~

Figure 4.8: Questions to Characterize Vacant Land (Example)

Select from list of potential VEAs, the VEAs to be analyzed (Steps 5 & 6)

Given the decision maker/user's responses to the questions in the previous step, some VEAs may not be feasible or it may not fulfill the primary TxDOT objective. These VEAs will therefore be further analysis (see Figure 4.9). The decision maker/user may also elect to disregard potential VEAs, which were not eliminated by the answers to questions in the previous step. In the example used herein, the decision maker/user decided to disregard geothermal energy from further analysis, thereby only three of the four potential VEAs remained (see Figure 4.9). A detailed explanation on how the asset characteristics affect (i.e., answer to the questions) the eliminators of potential VEAs is found in Appendix III.

VEA Framework

- Increase Revenue Stream (Vacant Land)
  - Potential VEAs:
    - **Property Management (e.g., sell, lease, or barter)**
    - **Leasing: Utility (e.g., telecommunication antenna)**
    - Advertising
    - Parking lot
    - Biomass & Biofuel
    - **Solar Panels**
    - Wind Turbine
    - **Geothermal Energy**

Figure 4.9: Selected VEAs for Further Analysis (Example)

Information about Potential Benefits, Impacts, Barriers, and Challenges Associated with Each VEA (Steps 7 and 8)

Prior to assessing each potential VEA, the user has to gain an understanding of the benefits, requirements, and impacts of the VEAs, as well as their implementation challenges. To facilitate this understanding, a summary of advantages and disadvantages/requirements is provided (see Appendix IV) for each VEA. In addition, a link to best practice examples uncovered during the literature review is also provided (see Appendix II and Appendix VI). The user is also able to access technical information about each VEA presented as Chapter 3 in this report. Figure 4.10 provides the advantages and disadvantages/requirements of one potential VEA (Airspace Leasing: Utilities) as an example. Figure 4.11 provides a best practice example for another potential VEA: Solar Panels.

VEA Framework

Airspace Leasing (Utilities)

Go to Examples

Advantages	Disadvantages / Requirements
▪ Enhanced and available telecommunication signals can contribute to social and educational development, as well as help promote economic development and create jobs. ▪ Can enhance safety in remote areas (e.g., tornado warming, communication of animal carcasses, existing obstacles, pavement conditions, and severe weather conditions). ▪ Several potential ways to implement this VEA. ▪ Can be even easier to implement if considered in new highway projects. ▪ Can provide the state access to technology infrastructure. ▪ Can yield a better telecommunication network, helping TxDOT and other public agencies to improve their information management systems and, consequently, enhance their services, implement an efficient maintenance program, and make better decisions. ▪ TxDOT already has airspace agreements for utilities that generate revenue, but not a formalized program. A formal program could bring more contracts and revenue for the agency and state. ▪ Some applications can be implemented with a short-term agreement (5 years) ▪ Can facilitate the implementation or expansion of TxDOT's Advanced Rural Transportation System (ARTS), Dynamic Message Signs, 511 travel information, and Highway Advisory Radio.	▪ Requires license and permits such as environmental ▪ Need to comply with the FHWA and ASSTHO guidelines and requirements, as well as NEPA. Some policies may be out of date and not address new technologies. ▪ Importance of contractual agreement (i.e., liabilities and responsibilities) and legal counsel during the process. ▪ Only applicable to private utilities ▪ Some utilities can entail safety and environmental concerns (e.g., explosion, contamination, leak, and crash) ▪ May cause traffic disruption and hazardous situation during construction and maintenance. Importance of good planning and assessment, as well as access to the site. ▪ Requires a formalized, clear, and public (open) process (i.e., fair market price, equal right to all interested parties, auction and bid, specifications, and guidelines) ▪ Requires a construction and maintenance plan (i.e., access, minimize impacts on traffic, safety, and execution method) ▪ Some applications require special considerations such as buried depth, concrete coat, and reinforcement. ▪ Private companies will need to have unrestricted access to ROW or public properties. ▪ May compete with private sector (e.g., tower companies).

Figure 4.10: Advantages & Disadvantages/Requirements (Example)

Go to Adv./Disadv.

VEA Framework

Example: Solar Panels

Go to Technical Memorandum

Oregon DOT (ODOT) is the pioneer in implementing solar panels in highway ROW in the U.S. In December 2008, ODOT concluded the installation of the first solar arrays project at the interchange of IH 5. The arrays can produce up to 117 KWh annually, i.e., 1/3 of the energy needed on the site. Basically, the solar arrays feed the grid with the electricity produced during the day whereas at night the grid supplies the electricity for interchange lighting.

Currently, SMUD Sacramento (California) is exploring a 594 solar panel project. Also, Caltrans is analyzing the feasibility of installing solar charge stations for electrical vehicles along highways, as well as the installation of solar panels for light poles.

In 2010 the Ohio DOT, in conjunction with the University of Toledo, installed a 100KW solar array—composed of 966 rigid solar panels and 198 flexible solar panels—in the ROW off IH 280 and Greenbelt Parkway in Toledo, OH. The solar array provides all the the entire electricity demanded at the Veteran's Glass City Skyway Bridge, which has a 196-foot lighted pylon containing 384 light emitting diode fixtures.

A number of solar projects can be found in European and Oceania transportation ROW. Germany, for example, has invested € 11 million in a solar panel project on top of a tunnel on highway A3 that has a 2.8 MW capacity. It is expected that the investment cost will be recovered in 16 years from cost savings. The 16,000 solar modules occupy 2.7 km and will provide electricity to nearly 600 houses. In Australia and some European countries, solar panels have a "dual use." Besides energy generation, the panels also act as sound barriers.

Figure 4.11: Solar Panel Best Practices (Example)

Understand the Seven Criteria and Assign Criterion Weights (Steps 9 & 10)

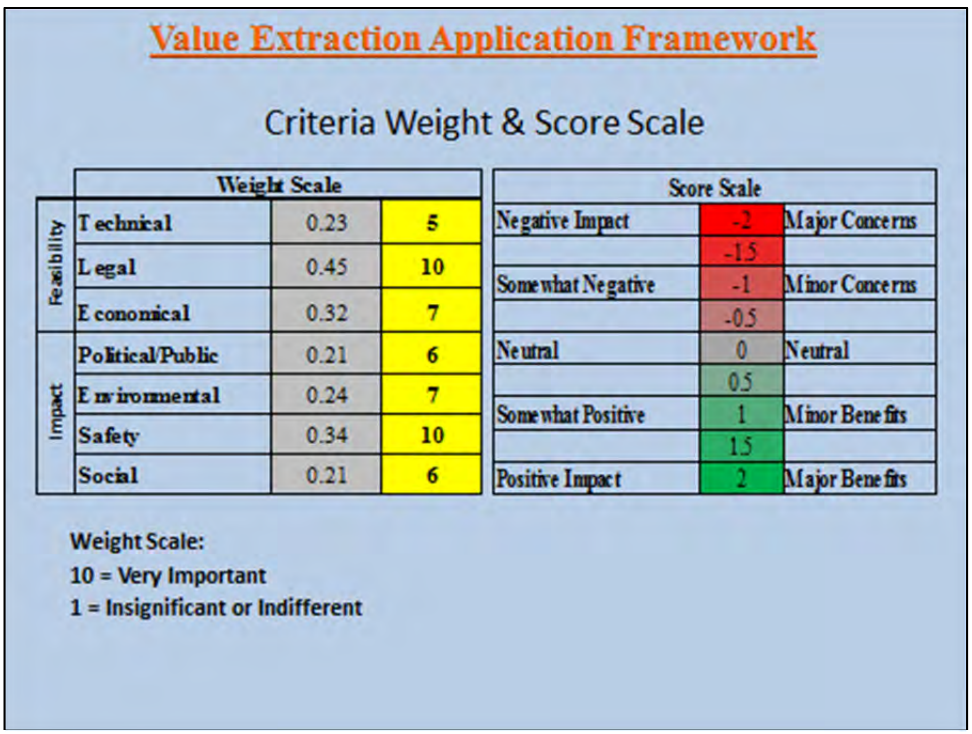
The second step preceding the assessment of each potential VEA is assigning weights to the seven criteria in accordance with their respective importance in influencing the outcome. Also, a link to the definition of each criterion—as noted in Chapter 2—is provided (see Figure 4.12). As explained in Chapter 2, the user can resort to different methods to weigh the criteria, but ultimately the weights need to be normalized in terms of the feasibility and impact criteria categories. In the example used, a scale of 1 to 10 was adopted−see the yellow column in the left table in Figure 4.13. The grey column in Figure 4.13 shows the calculated normalized weights. Finally, the right table in Figure 4.13 provides the scoring scale.

VEA Framework

Go Back

CRITERION	DESCRIPTION
Technical Feasibility	Technical Feasibility measures requirements for facilitating and ensuring the successful implementation of a VEA. For example, site characteristics are fundamental to the technical feasibility of several VEAs such as solar panels (e.g., proximity to transmission lines, terrain, and minimum of 5 acres of available land) and biomass (e.g., minimum of 15 inches rainfall, soil characteristics, distance to biorefineries, and minimum of 1 acre of available land). Technical feasibility also concerns engineering and construction standards and requirements. For example, to construct a building over a highway the distance between columns (i.e., free span), minimal clearance, construction methods, and access to the jobsite can impose challenges and difficulties, thereby precluding or preventing project execution.

Figure 4.12: Definition of Technical Feasibility Criterion



Value Extraction Application Framework

Criteria Weight & Score Scale

	Weight Scale		
Feasibility	Technical	0.23	5
	Legal	0.45	10
	Economical	0.32	7
Impact	Political/Public	0.21	6
	Environmental	0.24	7
	Safety	0.34	10
	Social	0.21	6

Score Scale		
Negative Impact	-2	Major Concerns
	-1.5	
Somewhat Negative	-1	Minor Concerns
	-0.5	
Neutral	0	Neutral
	0.5	
Somewhat Positive	1	Minor Benefits
	1.5	
Positive Impact	2	Major Benefits

Weight Scale:
10 = Very Important
1 = Insignificant or Indifferent

Figure 4.13: Assigning Criterion Weights (Example)

Analyze each VEA using the Evaluation Matrix (Step 11)

In this step, each potential VEA is assessed using the evaluation matrix developed in this research project and discussed in Chapter 2. At this point, the user should have a clear understanding of each potential VEA, its benefits, challenges, and impacts.

As presented in Chapter 2 and illustrated in Figure 4.14, the evaluation matrix comprises a set of statements pertaining to potential impacts—positive or negative -concerns, and requirements given the seven criteria explained in the previous step. The user has to assign a score from -2 to 2 to each criterion when assessing each statement (see Figure 4.14). The total score for the feasibility and impact categories is calculated by summing the contribution of each criterion included in the category. The contribution of each criterion is calculated by multiplying the respective normalized weight of the criterion with the average score assigned to each statement (see Figure 4.14). Appendix V presents the statements for each VEA included in the evaluation matrix.

Value Extraction Application Framework

Property Management

#	Criterion	FEASIBILITY: Technical	FEASIBILITY: Legal	FEASIBILITY: Economical	IMPACT: Political/ Public	IMPACT: Environmental	IMPACT: Safety	IMPACT: Social	Feasibility Score	Impact Score
1	Trained in-house staff in ROW and Real Estate management	1		-0.5						
2	In-house staff member to champion the evaluation and implementation of a property management application	2		-0.5						
3	Ease of integrating property management application in TxDOT's organazational and decision-making stucture	-0.5								
4	Availability of resources to update databases and/or GIS inventory of assets	1			1					
5	In-house resource to systematically review and assess current asset and future asset needs	0.5			1.5					
6	Willingness to invest in resources such as, information system, website, and GIS system	1		-0.5	-0.5					
7	Access to TxDOT's property inventory to characterize property assets (e.g., size, location, value, maintenance cost, and overall condition)	2								
8	Ability to communicate, involve, and share information with general public and stakeholders about the value extraction application project (i.e., transparency and equal access to information)	1			1.5					
9	Current value (i.e., market/Real Estate price) of the property	-0.5	1	2	1					
10	Current maintenance expenses on the property asset and potential savings if disposing of the property			2						
11	Formal procedures/guidelines available to conduct/implement TxDOT property management program	0.5	2		0.5					
12	Anticipated impacts on nearby community of "new" property use (i.e., new owner or lessee), including potential to mitigate anticipated impacts				-0.5	-1	0.5	1.5		
13	Anticipated environmental impacts and mitigation measurements of "new" property use		0.5	-0.5		1.5		0.5		
14	Permit or license required for "new" property use		1.5	-0.5						
15	Financial resources of and warranties (i.e., bond approval and surety) provided by the developer interested in buying/leasing/swapping property		2	2						
16	Anticipated direct and indirect jobs created and economic development impacts resulting from "new" use of property			2	2			2		
17	Anticipated benefits to TxDOT (e.g., financial, technical, and safety) of disposing of "obsolete" assets	2		2	2		0.5	1		
18	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD)		-0.5		-1					
19	Potential conflict with zoning law, city's master plan, and transportation's plan		0.5		-0.5			-0.5		
20	Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" use)				0.5					
21	Legal constraints/issues that can jeopardize the transaction		2							
22	Available legal consultants/resources to implement TxDOT property management program		0.5	-0.5						
23	Available legal consultants/resources to advise and review transactions and contractual agreements		1.5	-0.5						
24	Resources required to train or acquire in-house legal resources/counsel			-0.5	-0.5					
25	TxDOT's exposure in terms of liability and risks		0.5	-0.5	-0.5					
26	Investment required by TxDOT to implement the Value Extraction Application			-0.5	0.5					
	TOTAL CONTRIBUTION OF EACH CRITERION	0.21	0.48	0.11	0.10	0.06	0.17	0.19	0.79	0.52

Figure 4.14: Evaluation Matrix for Property Management (Example)

Analyze VEA(s) Given Feasibility and Impact Scores and Identify VEA(s) for Further Consideration (Steps 12 & 13)

The outcome of Step 11 is a chart displaying the feasibility and impact scores of each VEA assessed (see Figure 4.15). The feasibility score is presented as the X-axis coordinate and the impact score is presented as the Y-axis coordinate. In the example, it is evident that the property management VEA is the most feasible and has the highest impact score given the specific circumstances. Note, however, that the outcome reflects the inputs entered by the user and will vary given changes to criteria weights and/or assigned scores. Furthermore, as stated in Chapter 2, a positive impact score does not necessarily imply a lack of concerns or challenges surrounding the implementation of the VEA. The evaluation matrix provides TxDOT with a mechanism to assess different VEAs and discard those that are not feasible and/or have a negative impact score.

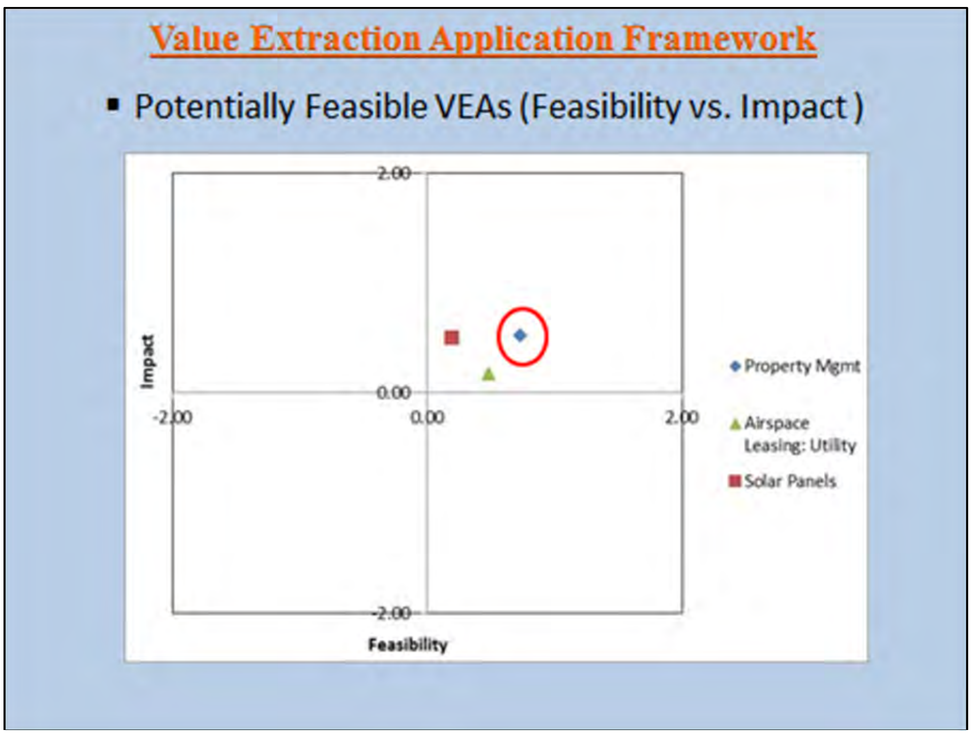


Figure 4.15: Outcome of Evaluation Matrix (Example)

Identify Stakeholders and Assess Interest and Influence (Step 14)

Once TxDOT has identified a potential VEA for implementation, the next step is stakeholder outreach. As mentioned earlier, a general outreach approach or attempting to reach out to a large and diversified group of stakeholders with various levels of interest and influence can be ineffective and costly. On the other hand, failing to reach out to specific stakeholders can jeopardize the VEA's implementation.

Similar to the technique used to evaluate and compare potential VEAs, this research provides the user with a technique to assess the level of interest and influence of identified stakeholders. In summary, influence is the ability of a stakeholder to impede or expedite the implementation of a VEA, while interest represents the importance of the application to the stakeholder. This evaluation allows for the identification of key stakeholders and focused public outreach. The importance of stakeholder analysis and the concept of influence and interest are discussed in Chapter 5.

To assist TxDOT in identifying key stakeholders, a list of potential stakeholders is provided for each VEA (see Appendix VII). Figure 4.16 illustrates the identified stakeholders for the property management application. The user has to evaluate each stakeholder on a scale of 0 to 5 (see Figure 4.16) in terms of its influence and interest. Similar to the evaluation matrix, a chart is provided to facilitate the visualization and identification of stakeholder categories (see Figure 4.16). Chapter 5 explains each of the quadrants in the chart in detail.

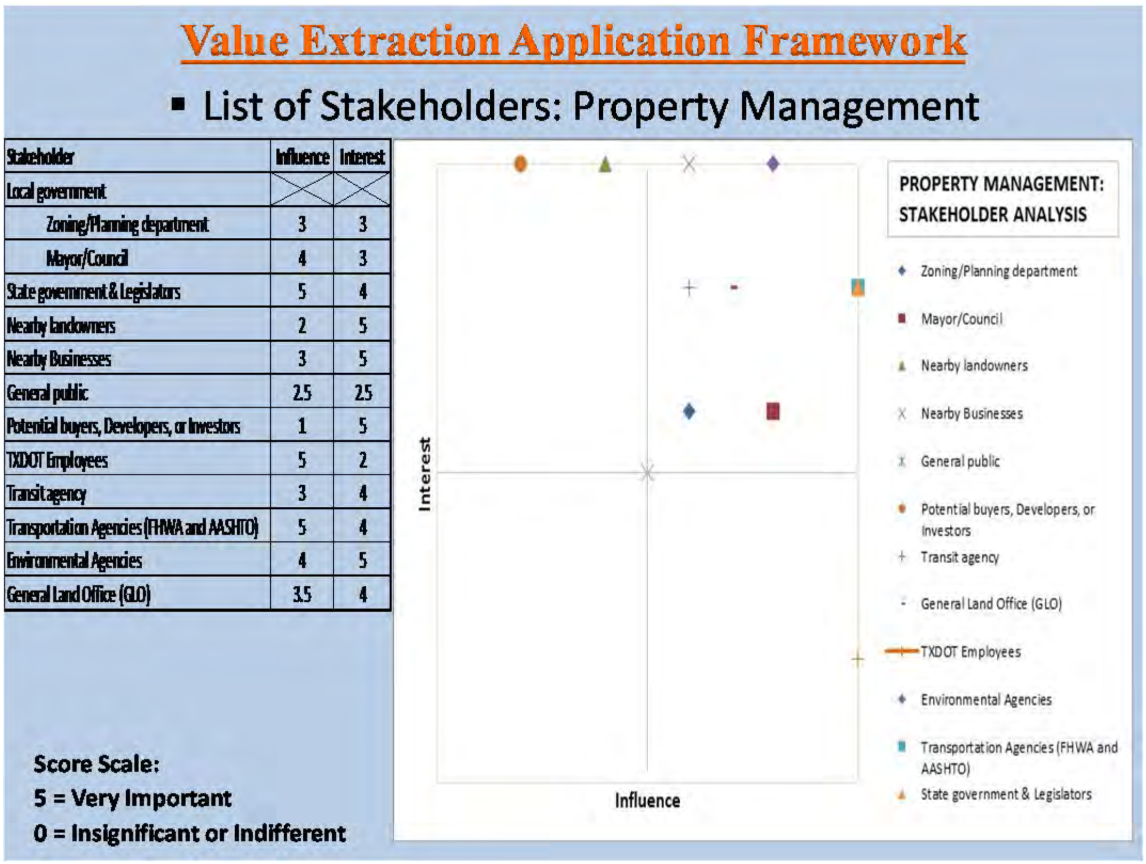


Figure 4.16: Stakeholder Analysis (Example)

Analyze the Best Approach and Outreach Technique for Stakeholder (Step 15)

Once the stakeholder categories have been identified the next step is to determine the best approach and outreach technique to engage the identified stakeholders. Several techniques exist to conduct stakeholder outreach, but these vary substantially in terms of cost and effectiveness. Hence, it is fundamental to determine the best approach to reach out to different stakeholder categories. Chapter 5 lists and discusses available outreach techniques.

Conduct Detailed Feasibility Study and Public Outreach (Step 16, 17, and 18)

After identifying the potential VEA(s) for implementation, identifying stakeholder categories, and determining the outreach approaches, TxDOT subsequently has to conduct three tasks to ensure successful implementation. First, TxDOT has to conduct the public outreach and address any concerns or issues that may arise. TxDOT also has to conduct a detailed feasibility study for the selected VEA, including an economic and financial analysis, technical analysis, and resource analysis. Ultimately, when the VEA is implemented legal and contractual agreements will be required, as well as design plans, construction schedules, and mitigation measures.

4.2 Concluding Remarks

The methodological framework presented in this chapter was developed to assist and guide TxDOT in identifying the most appropriate VEA(s) for implementation and the stakeholder categories that should be engaged. The methodological framework comprises a series of steps/questions intended to filter potential VEAs given the property asset and the agency's objective. Multi-attribute criteria decision analysis is then used to evaluate and compare different potential VEAs. The methodological framework also helps TxDOT to recognize and understand barriers, challenges, and impacts associated with each VEA. Nonetheless, some issues that may affect the implementation may not be covered in this framework. Also, additional information about current technologies, local vendors, available funding, and project specifics may be valuable prior to or during the evaluation process. Finally, it is important that TxDOT documents and maintains lessons learned to update the questions and potential VEAs included in this framework. New VEAs may emerge and technologies may become more cost-effective and/or efficient, thereby altering the requirements and/or reducing barriers of some of the VEAs.

In evaluating the potential VEAs, it is also recommended that the TxDOT user consults with agency staff from the Environment, Traffic Operations, Planning, Public Relations, Maintenance, and ROW Divisions, as well as the Office of General Council. This will assist the user in evaluating each criterion in the evaluation matrix. Also, the methodological framework may not yield one "right" VEA. The ultimate decision on whether to pursue which VEA will thus remain with the TxDOT user.

Chapter 5. Stakeholder Analysis

This chapter introduces and discusses the stakeholder[8] analysis framework that was developed to assist TxDOT in identifying, reaching out, and involving different stakeholder categories when considering VEA implementation.

5.1 Stakeholder Analysis Framework

Stakeholder outreach is an important component of most transportation projects. However, a general outreach approach or attempting to reach a very large and diverse group of stakeholders with various levels of influence and interest can be ineffective and costly. Too often public outreach efforts are conducted with very few attendees or without achieving the set objectives. On the other hand, failing to reach out to key stakeholders[9] can jeopardize the VEA implementation. Therefore, meaningful stakeholder outreach requires a targeted approach to ensure that outreach efforts are conducted in an efficient and cost-effective manner. To do so, a stakeholder analysis framework that comprises a process to identify potential stakeholders, categorize stakeholders according to interest and influence, identify key stakeholders, and select and implement the most appropriate outreach technique was developed (see Figure 5.1). This chapter explains each step of the stakeholder analysis framework in detail.

8 Stakeholders are persons, groups, or institutions with interests in a project or policy or who may be directly or indirectly affected by the process or the outcome. (World Health Organization, ND)
9 Key Stakeholders are those who can significantly influence, or are important to the success of the project." (World Health Organization, ND)

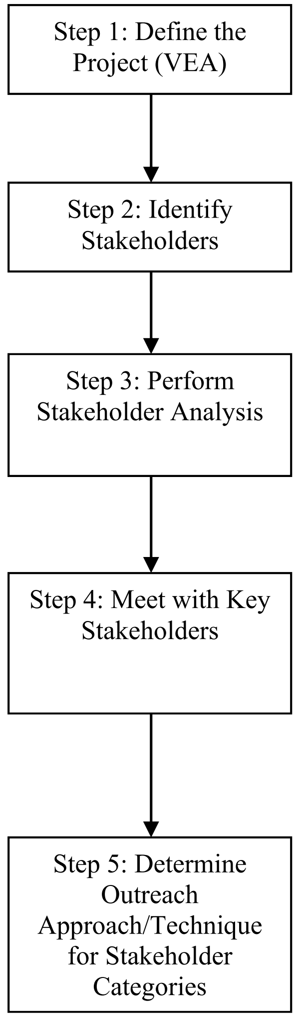


Figure 5.1: Stakeholder Analysis Framework

Step 1: Define the Project (VEA)

Before any stakeholder analysis is conducted, the goals and objectives of the VEA must be defined so that they can be effectively communicated to the stakeholders. Furthermore, outlining the potential advantages and disadvantages of the VEA helps in identifying the stakeholders.

Step 2: Identify Stakeholders

Based on the characteristics of the VEA, its location, and the likely impacts, potential stakeholders can be identified. This includes both internal (different departments within the organization) and external stakeholders (all interested and influential parties outside of the organization). Indeed, potential stakeholders include those that could be impacted, those that could influence the implementation of the VEA, those that need to be involved, and those whose understanding needs to be enhanced to enable them to be involved. Potential stakeholders thus could include individuals that represent the energy sector (e.g., solar and utility developers), public agencies (e.g., MPOs, counties, and cities), the railroads, parks and wildlife, special interest groups (e.g., land developers, private rest area owners), and the general public.

A list of stakeholders that would generally be associated with each VEA can be found in Appendix VII. Although it is not always possible to think of every interested party, the following are potential questions/approaches that may assist in identifying as many stakeholders as possible.

Questions to Ask

The following are questions that can be asked to assist in identifying stakeholders:

- Who might be affected?
- Who might influence the implementation of the project?
- Who can delay the project? Who can stop it?
- Who might oppose the project?
- Who might be involved in the project?
- Of those stakeholders identified, who might they influence to be interested in the project?
- Who may support the project?

Interest Type

Isolating particular interests can also help make the process of identifying stakeholders more manageable, as each stakeholder likely has a primary reason for their interest in the VEA as follows:

- <u>Economic</u> – those who may gain economically or suffer an economic loss, or even those who may be concerned that other stakeholders may see a gain or loss;
- <u>Application</u> – those who may use or operate the VEA, or those who may suffer a loss/reduction in the use of another resource;
- <u>Regulatory</u> – government agencies responsible for regulations or other civic-related items that the VEA may need to meet or falls under;
- <u>Proximity</u> – those nearby who the VEA could impact, including landowners and businesses, which could involve groups at great distances depending on the impact (e.g., visual, environmental, and traffic, etc.); and
- <u>Political</u> – those who may feel compelled to be involved due to their values, elected status, or desire to be involved in certain spheres of influence; and
- <u>Location</u> – municipality, county, and other local jurisdictions, rural or urban communities, states, corridors, and regional coalitions (including Mexico).

Identity

Stakeholders can also be grouped in terms of the sector they represent:

- Public – external governmental and public entities that may have authority over the VEA, can be influenced by the public to take interest in the VEA or have insight or reservations about implementing the VEA;
- Internal – other departments within TxDOT that may have issues with the VEA or resources to contribute;
- Private – businesses and residential organizations that may be impacted;
- Interest Groups – coalitions, advocacy groups, and other organizations that have a core interest that may be in line or in conflict with the VEA (e.g., environmental, wildlife, and trade); and
- Individuals – homeowners, landowners, and community leaders that may be impacted.

Step 3: Perform Stakeholder Analysis

Two dimensions are used to categorize stakeholders and to determine their potential role in the implementation of the VEA: interest and influence. Interest is defined as the importance of the VEA given the stakeholder's values, operations, and/or goals. Influence is defined as the stakeholder's ability to alter the implementation of the VEA, whether that means championing, changing the scope, delaying, or completely stopping the implementation of the VEA. Thus, stakeholder analysis aims to assess the interest and influence of the identified stakeholders in an effort to identify key stakeholders that may impact the acceptance and ultimate success of implementing different VEAs.

As discussed in Chapter 4, the stakeholder analysis is performed by assigning interest and influence scores—on a scale of 0 to 5—to identified stakeholders. Each stakeholder is then ranked according to their interest and influence to determine the appropriate level of engagement for that stakeholder category, and to understand how they might become involved in implementing the VEA. In addition, a chart (see Figure 5.2) is plotted with a stakeholder's influence score represented as the X-axis coordinate and the interest score presented as the Y-axis coordinate. Figure 5.2 also shows the meaning of each quadrant of the chart.

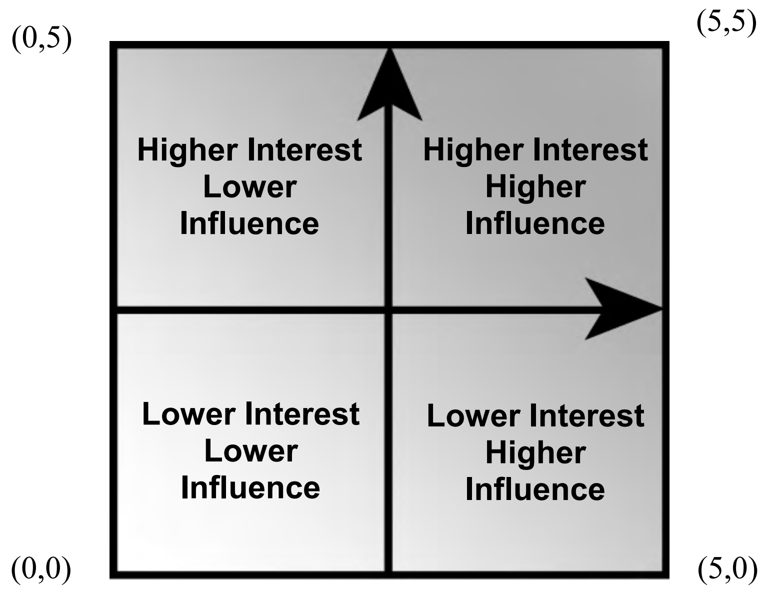


Figure 5.2: Stakeholder Interest vs. Influence Diagram

Interest

Interest often relates the likelihood that the stakeholder wants to be involved and engaged. Alternatively, it can also be viewed as the likelihood of conflict arising if the stakeholder is omitted. There are three general categories of interest:

1. Interest from direct impact or ideological beliefs;
2. Interest from indirect impact; and
3. No interest.

Interest derived from direct impact or ideological beliefs is regarded as the highest form of interest. Indirect impact typically generates a moderate amount of interest, but can include stakeholders whose interest were sparked by other highly interested stakeholders that may not have much influence over the implementation of the VEA. Lastly, no interest potentially requires that these stakeholders may need to be notified of the VEA, but their level of involvement will ultimately be determined by their level of influence. Interest should, however, be monitored, as a stakeholder's interest may change given the point in the process, or given the influence from other stakeholders.

Influence

Influence refers to the stakeholder's ability to impact the implementation of the VEA. Like interest, influence can be categorized as:

1. The ability to stop or accelerate the implementation of a VEA;
2. The ability to delay or champion the implementation of a VEA;
3. The ability to disrupt or bring together key relationships; and
4. No influence.

The ability to stop or accelerate the implementation of a VEA is the highest level of influence as these stakeholders are essentially decision-makers. Some may have a low level of interest, but should be involved as they can be influenced by other stakeholders to become more involved. The ability to delay or champion the implementation of a VEA means the stakeholder does not necessarily have direct influence over the project, but the stakeholder can complicate or persuade others to support the implementation of a VEA. Lastly, a stakeholder may be able to influence relationships in a negative or positive manner, such as bringing together multiple stakeholders to approve or disapprove the implementation of a VEA. Influence can be weighted by the likelihood of being exercised given the level of interest and where the agency is in the process, but the potential for exercising influence should always be monitored.

Step 4: Meet with Key Stakeholders

Once key stakeholders have been identified (i.e., stakeholders with high levels of interest, high levels of influence, and both), meetings with these stakeholders should be conducted.

Introduce Project to Stakeholders

An initial stakeholder meeting allows stakeholders to be introduced to the project directly. At this meeting, the purpose and goals associated with the VEA can be directly communicated and the initial reaction from stakeholders can be ascertained.

Identify Potential Conflicts

Perhaps the most important reason for an initial meeting is that it can allow for any potential conflicts to be identified early on, allowing the agency time to prepare and even make changes to the project to address concerns. Furthermore, this information can help determine the level and type of outreach that will be needed for different stakeholder categories.

Identify Omitted Stakeholders

Meeting with key stakeholders can help the agency identify any omitted stakeholders with high levels of interest or influence or both. There are a host of reasons for why some stakeholders may feel that they should be consulted, including stakeholders that may have been thought of as being too far away from the implementation site to have interest and/or influence. Key stakeholders can help to identify omitted stakeholders and avoid surprises later on in the VEA implementation process. The same stakeholder analysis should be applied to newly identified stakeholders as well.

Step 5: Determine Outreach Approach/Technique

Based on the level of interest and influence of each stakeholder, and the insight gathered from initial meetings, an outreach plan should be developed for each quadrant of the stakeholders (see Figure 5.2). In general, those with high levels of interest and influence will require a substantial engagement. These stakeholders will also want to know how their input will be used in the implementation of the VEA. If stakeholders with high interest levels are omitted, they may seek assistance from stakeholders with less interest, but high levels of influence to impact the implementation of the VEA. All stakeholders, however, should receive regular updates and information on the implementation process, as well as an avenue to raise concerns.

The type of outreach performed will differ depending on the stakeholder category.

5.2 Concluding Remarks

Stakeholder outreach is essential to ensure successful VEA implementation. A general outreach approach or attempting to reach a very large and diverse group of stakeholders with various levels of influence and interest can, however, be ineffective and costly. On the other hand, failing to reach out to specific stakeholders can jeopardize the implementation of the VEA. Therefore, a stakeholder analysis framework that comprises a process to identify potential stakeholders, categorize stakeholders according to interest and influence, identify key stakeholders, and select and conduct the most appropriate outreach technique was developed in this chapter to assist TxDOT in reaching out to stakeholders in a cost-effective manner.

Chapter 6. Conclusions and Recommendations

The primary objective of this research was to identify potential VEAs—and their respective barriers, challenges, requirements, benefits, and impacts—that can be implemented to help TxDOT save costs, increase revenue streams, or enhance societal goals. This research also aimed to provide TxDOT with insight and guidance in determining when, where, and under what circumstances to pursue the implementation of which VEA(s), as well as structured guidance on identifying and involving key stakeholders in the implementation of feasible VEA(s).

This chapter provides conclusions and recommendations for enhancing the decision-making framework developed to increase the likelihood of success when pursing the implementation of VEAs. The chapter concludes with some remarks regarding the contribution of this research to the existing knowledge base on this subject.

6.1 Conclusions

This section offers the following concluding remarks pertaining to the VEA(s), their respective barriers, requirements, challenges, benefits, and impacts:

- Most of the published literature reviewed as part of the study team's comprehensive literature review comprised short articles, commercial presentations, and pilot project fact sheets/summaries. Most of the past research addressed specific aspects of individual VEAs (e.g., wildlife crossings, airspace leasing for buildings, and carbon sequestration). In general, in-depth research, scientific data, and conclusive results were lacking for most VEAs.
- Some VEAs are currently being piloted, while others are well-established practices (e.g., property management, advertising, and airspace leasing for parking lots). For most VEAs, however, only limited quantitative information (e.g., required to measure efficiency or cost effectiveness) is available. Lessons learned and insights were thus largely obtained through interviews with knowledgeable agency staff.
- All information gathered was compiled and synthetized, yielding a comprehensive and detailed review (see Chapter 3) of each of the identified VEAs in terms of seven defined criteria.
- The evaluation matrix developed comprises and highlights important aspects associated with each VEA (i.e., barriers, challenges, requirements, benefits, and impacts) that must be considered or addressed by TxDOT during the assessment of and implementation of the VEAs.
- Two identified VEAs—i.e., solar roads and piezoelectric pavements—were discarded from further consideration, as these technologies are largely experimental. No detailed technical or economic information was available for these two applications.
- The use of transportation ROW and properties for renewable energy projects has increasingly gained attention and has been piloted in the U.S. and overseas. Several pilot projects have thus resulted in initial findings and information about challenges, requirements, and benefits.

The following remarks pertain to the research objective to provide TxDOT with comprehensive insight and guidance in determining when, where, and under what circumstances to pursue the implementation of which VEA(s):

- A methodological framework, which includes an evaluation matrix, was developed to guide and assist TxDOT in identifying and implementing the most promising VEA, given TxDOT's land asset and objective.
- The methodological framework comprises sequential steps that filter out the inappropriate VEAs given TxDOT's objective and the site characteristics through an initial set of questions. The first questions address the conditional factors (i.e., type of asset, primary objective, and major characteristics of the land asset) that would prevent the implementation of potential VEAs or impede the agency from achieving its objective. This initial step is not subject to the judgment or assessment of the user.
- The evaluation matrix (the main component of the methodological framework) can be used to compare potential VEAs. The evaluation matrix thus assists the user in identifying potentially feasible VEA(s).
- The evaluation matrix, however, requires weighting and assigning scores to criteria, which introduces subjectivity. Changes in these parameters may thus affect and alter the final outcome—i.e., feasibility and impact of potential VEAs.
- The methodological framework, identified VEAs, and evaluation matrix reflects current available technologies, current prices (e.g., solar panel costs, etc.), and existing federal and state legislation, as well as TxDOT policies and regulations. Changes to any of these can affect the feasibility of the identified VEAs. Also, new technologies may emerge, creating not only new opportunities but potentially new VEAs. Hence, the methodological framework and evaluation matrix may require periodic updates.

The following remarks pertain specifically to the feasibility of the 11 VEAs identified during the literature reviews:

- The feasibility of any of the VEAs is site specific and depends on numerous factors that must be carefully considered and analyzed. Similarly, the financial outcomes cannot be generalized and requires specific and detailed analysis.
- Leadership (i.e., a champion) is essential when pursuing the implementation of a VEA. TxDOT should thus identify an in-house staff member to champion the evaluation and implementation of potential VEA(s).
- Public outreach and involvement is fundamental to avoid potential opposition and delays to the implementation of feasible VEAs.
- Safety is always a major concern for any project along highway ROW. However, appropriate design features (e.g., guard rails and clear zone) and site selection criteria can eliminate or mitigate potential safety concerns.

- Environmental awareness and protection have increasingly gained attention and are important components and considerations of any public project. Specific demands for transportation projects to be more sustainable and environmentally friendly are made at the federal level. Furthermore, environmental impact analysis (e.g., the NEPA process) may impact the implementation of some VEA(s).
- Legislation and regulatory agencies govern the activities public agencies. Hence, any legal aspects must be considered when identifying, evaluating, and implementing feasible VEAs. Chapter 3 provides insights regarding the laws, regulations, and policies that may affect, dictate, or influence the implementation of VEA(s).
- Written agreements protect the DOT from unnecessary risks and liabilities. Thus, legal counsel must participate when implementing all VEA(s), but specifically when a private entity is involved (e.g., public-private partnerships and airspace leasing).
- Various business models exist for how TxDOT can approach and relate to private entities. However, some business models can be very complex and demand significant administrative and legal resources. Selecting the most appropriate business model is not only important to achieve the agency's objective, but also to maximize the benefits when implementing the VEA.
- Permits and licenses are typically needed.
- Each VEA has particular aspects that have to be carefully considered, analyzed, and managed.

6.2 Recommendations

This research has contributed to an increased understanding of the different VEAs that can help TxDOT and other DOTs save costs, increase revenue streams, or enhance societal goals. This research also provided TxDOT and other DOTs with a framework to systematically review and identify potentially feasible VEA(s) given an agency's property asset and intended objective. Based on the research conducted, the research team recommends that

- TxDOT consider pursuing the implementation of a formal property management program, e.g., including investment in a GIS and/or other information management system. A formal property management program can facilitate the identification of opportunities for VEA implementation, as well as the actual implementation of feasible VEAs.
- When evaluating potential VEAs, TxDOT involve employees with a diverse background and expertise (e.g., maintenance, traffic, safety, public relations, legal, and construction personnel) to evaluate and anticipate potential challenges and concerns. In addition, TxDOT should assign one person—preferably an in-house staff member—to champion and lead the process. This person should be empowered to make decisions.
- TxDOT document lessons learned, monitor results (e.g., time, cost, revenue, resources, and issues), and conduct a post-evaluation of implemented VEAs (e.g.,

benefits and impacts) to enhance the decision-making process and methodological framework.

- Even if the evaluation matrix and methodological framework indicates a VEA is potentially economically feasible (i.e., a positive score for the economic criterion), TxDOT should conduct a detailed economic and financial assessment considering site specific data/information, values, and quantities to determine the actual financial benefits, payback period, and costs involved.
- Because most of the VEAs involve a private party, TxDOT should carefully evaluate and decide who to partner with. Special attention should be given to the financial resources of and sureties and warranties provided by the private entity or project developer. TxDOT should also retain legal counsel to assist and review any written agreement and/or contractual document, looking mainly at liabilities, risks, and responsibilities.

Appendix I: Legal Review

The research team reviewed and analyzed what TxDOT can currently accommodate within its right-of-way (ROW), as well as the uses that ROW can currently be utilized for according to federal and state statutes and state administrative code. Included within this review is a synopsis of the current federal rules regarding the use and accommodation policies for ROW. A review of how the highway beautification act also intersects into the use of ROW and adjacent property to ROW was also undertaken. The team also reviewed previous legal analysis conducted in TxDOT research 0-6495 regarding the potential to place high voltage transmission lines in ROW.

Introduction

Over the past 30 years federal regulations as well as guidance developed by the Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO) have been very consistent in keeping ROW protected from other potential uses and except for the accommodation of utilities, have restricted the commercialization of rest-areas, and have actively managed the use of billboards and other types of 'blight-creating' uses such as junk yards, and car storage yards adjacent to ROW. One area that stood out for the purposes of this research has been the long-standing policy of utility accommodation within, across, and adjacent to ROW. Utility accommodation was historically viewed as *beneficial for the public good*, and the practice of bundling together transmission of goods and electrons began with placement of the telegraph system within the railroad ROW in the nineteenth century as the country developed. During the twentieth century multiple utility systems including electricity transmission, oil and gas pipelines, and telecommunications cables, were laid across or adjacent to ROW and more recently have been laid longitudinally under the ROW. So the bundling of transportation and utility uses is a long-standing practice in the U.S.

Federal ROW Acquisition and Use: Statute Review

<u>Acquisition of ROW: 23 CFR Part 1 – General: Section 1.23</u>

23 Code of Federal Regulations (CFR)[10] Part I Section 1.23 Rights-of-Way stipulates the purposes whereby ROW can be acquired for federal aid highway projects. The interest that shall be acquired under Section 1.23 (a) shall be of such nature and extent *as are adequate for the construction, operation and maintenance* of a project. The use for which ROW is acquired is for *highway purposes*.

Paragraph (b) states that except as provided under paragraph (c) of this section, all real property, *including air space*, within the ROW boundaries of a project shall be *devoted exclusively* to *public highway purposes*. Paragraph (b) also notes that state highway departments are responsible for preserving such ROW free of all public and private installations, facilities or encroachments, *except for those approved under paragraph (c)* and those that the Administrator approves as constituting a part of a highway or as necessary for its operation, use or maintenance

10 Code of Federal Regulations can be accessed at: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=69038596f74496b2a96cbd4617454188&rgn=div5&view=text&node=23:1.0.1.8.39&idno=23#23:1.0.1.8.39.2.1.2

for public highway purposes such as information sites established and maintained under §1.35 of the regulations.

The exception in §1.23(c) allows for temporary or permanent occupancy *or use* of the ROW approved by the Administrator as either being in the *public interest* and will not *impair* the highway or *interfere with free and safe flow* of traffic thereon.

<u>Funding and Reimbursement: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate Section 710.203</u>

23 CFR Section710.203 details the conditions under which a DOT will be funded and reimbursed for ROW acquisition. In general the section requires the project to have been included in the Statewide Transportation Improvement Program (STIP), the DOT has executed a project agreement, NEPA provisions have been complied with, and costs have been incurred in conformance with state and federal law requirements.

Direct eligible costs that are covered include the cost of property incorporated into the final project and the associated direct costs of acquisition, unless provided otherwise. Participation is provided for real property acquisition and services associated with this, including incidental expenses, administrative settlements, and contracting costs for private acquisition services or the use of local public agencies (§710.203 (4)(b)). Damages, for cost of severance of consequential damage are covered, along with net costs of managing real property prior to and during construction, and payroll related expenses for technical guidance (§710.203 (4) (b) (3-4)).

The section also allows for the cost of property not incorporated into a project to be eligible for reimbursement under the following circumstances (§710.203 (4) (b) (6)):

(i) costs for construction material sites, property acquisitions to a logical boundary, or for eligible transportation enhancement, sites for disposal of hazardous materials, environmental mitigation, environmental banking activities, or last resort housing; and

(ii) the cost of acquiring easements outside the ROW for permanent or temporary use.

<u>Real Property Control: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate: Section 710.401</u>

This subpart describes the acquiring agency's responsibilities to control the use of real property required for a project in which federal funds participated in any phase of the project. Prior to allowing any change in access control or other use or occupancy of acquired property along the Interstate, the DOT shall secure an approval from the FHWA for such change or use. The DOT shall specify in the ROW operations manual, procedures for the rental, leasing, maintenance, and disposal of real property acquired with money under 23 CFR. The DOT shall assure that local agencies follow the State's approved procedures, or the local agencies own procedures if approved for use by the DOT.

<u>Real Property Management: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate: Section 710.402</u>

Under Section 710.403 (a) the DOT has to assure that all properties within the boundaries of the federally aided facility are devoted *exclusively* to the purposes of that facility and is preserved free of all other public or private alternative uses, unless these have been permitted by regulation or the FHWA. The *alternative use must be consistent* with the continued operation, maintenance, and safety of the facility and the use *shall* not result in the exposure of the facility's users or others to hazards. Under 710.403 (b) The DOT is required to comply with specific procedures in their ROW manual for determining when the real property interests is no longer needed. This includes provision for coordination among DOT divisions (including, maintenance, safety, design, ROW, environment and traffic operations).

The DOT under sub-section (c) *shall* evaluate the environmental effects of disposing or leasing property and must obtain FHWA approval under 23 CFR Part 771. DOTs are required to charge current fair market value or rent for the use or disposal of these property interests, including access control, if the properties were obtained with Title 23 United States Code (U.S.C) funding. An exception to this is provided under 710.403 (d) (1) through (5) of this section. Herein if property no longer needed for a project was acquired with public funding, the principle guiding disposal would normally be to sell the property at fair market value and use the funds for transportation purposes. The term fair market value as used for acquisition and disposal purposes is defined by State statute and/or State court decisions. Exceptions to the general requirement for charging fair market value may be approved in the following situations:

(1) With FHWA approval, when the DOT clearly shows that an exception is in the overall public interest for social, environmental, or economic purposes; nonproprietary governmental use; or uses under 23 U.S.C. 142(f), Public Transportation. The DOT manual may include criteria for evaluating disposals at less than fair market value. Disposal for public purposes may also be at fair market value. The DOT shall submit requests for such exceptions to the FHWA in writing.

(2) Use by public utilities in accordance with 23 CFR Part 645.

(3) Use by Railroads in accordance with 23 CFR Part 646.

(4) Use for Bikeways and pedestrian walkways in accordance with 23 CFR Part 652.

(5) Use for transportation projects eligible for assistance under 23 U.S.C, provided that a concession agreement, as defined in section 710.703, shall not constitute a transportation project.

Under §710.403 (e) the Federal share of net income from the sale or lease of excess real property shall be used by the DOT for activities eligible for funding under title 23 U.S.C. Under this provision, the project income derived from this sale does not create a federally aided project. No FHWA approval is required for property disposal that is located outside of the limits of the ROW if federal funds were not used in the property acquisition (§710.403(f)). Highway facilities where federal funds were used for ROW purchase or construction may be relinquished to another governmental agency for continued highway use under the provisions of 23 CFR 620, subpart B (§710.403(g)).

<u>Air Rights on the Interstate: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate: Section 710.405</u>

Section 710.405 promulgates FHWA policies regarding the management of airspace on the interstate for non-highway purposes. The section's preamble notes that while it deals with approval for actions on the highway, DOT contemplated airspace use, *must* assure that such occupancy, use, or reservation is in the public interest and does not impair the highway or

interfere with the free and safe flow of traffic as provided in 23 CFR 1.23 (710.405 (a)). This section applies to interstate facilities that received any assistance, through 23 CFR.

The sub-part does not apply to non-interstate highways, railroads, and public utilities that cross or otherwise occupy federally aided ROW, relocations of railroads/utilities for which reimbursement is claimed under 23 CFR Part 140 Subparts E and H, and bikeways and pedestrian walkways under 23 CFR Part 652 (710.405 (2) (i through iv).

The DOT may grant rights for temporary or permanent occupancy or use of Interstate airspace if the DOT has acquired sufficient legal right, title, and interest in the ROW of a federally assisted highway to *permit the use of certain airspace for non-highway purposes*; and where such airspace *is not required presently or in the foreseeable future* for the safe and proper operation and maintenance of the highway. The DOT must obtain prior FHWA approval, except where paragraph (c) of the section applies (710.405 (b)).

Under Paragraph (c) the DOT may make ROW available—without charge—to a publicly owned mass transit authority for public transit purposes where it serves the public interest, and can be accommodated without impairing safety, or future highway improvements. The section allows an individual, organization, company or public agency to submit a written request to the DOT for an airspace lease. If the DOT recommends approval, it must submit an application to the FHWA along with supplemental documentation describing the project and any proposed lease agreement. The submission is required to comply with provisions in the FHWA's Airspace Guidelines (710.405 (d)).

Comment: Opportunities exist here to utilize this type of exception for a public purpose type of value extraction project that includes transit, such as High Speed Rail.

Leasing of Property: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate: Section 710.407

Under 710.407 (a) the leasing of real property acquired with 23 CFR funds, shall be covered by an agreement between the DOT and lessee which must contain provisions to insure the *safety and integrity* of the federally funded facility. It shall also include provisions governing lease revocation, removal of improvements *at no cost* to the FHWA, adequate insurance to hold the State and the FHWA harmless, nondiscrimination, and access by the State Transportation Department (STD) and the FHWA for inspection, maintenance, and reconstruction of the facility. Section 710.407 (b) provides that where the proposed use requires changes in the existing transportation facility, such changes shall be provided without Federal funds unless otherwise specifically agreed to by the DOT and the FHWA. Section 710.407 (c) requires that any proposed uses of the ROW shall conform to the current design standards and safety criteria of the FHWA for the functional classification of the highway facility in which the property is located.

Comment: This sub-section provides TxDOT with opportunities to consider real property leases for implementation of VEAs

Property Acquisition Alternatives: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate: Section §710.501

The DOT can initiate early acquisition of real property, subject to compliance with Title VI of the Civil Rights Act 1964, and a determination that the early acquisition has not influenced the environmental assessment of the project including, the decision on need to construct the project, consideration of alternatives, and selection of design and location.

<u>Federal Assistance: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate: Section 710.603</u>

This section covers direct federal acquisition/federal assistance where the DOT is unable to acquire the required ROW or is unable to obtain possession with sufficient promptness. The provisions, however, are for acquiring any land and or improvements needed in connection with any project on the interstate system, such as defense access roads, public lands highways, park roads, and Indian reservation roads (§710.603 (a)).

The state is required to furnish the FHWA – to allow it to make the necessary finding to proceed with the acquisition – with information regarding the necessity for acquisition, a statement of the specific interests in lands to be acquired, including the proposed treatment of control of access, and the State DOTs intentions regarding acquisition, and subordination or exclusion of outstanding interests, including utility easements in connection with the acquisition.

Comment: A strong rationale would be required for TxDOT to justify requesting assistance with the acquisition of ROW for value extraction purposes that are not germane to highway purposes. Although the memo that was produced in 2009 regarding the location of high voltage transmission lines within ROW does note, that if the DOT has a policy of co-location, federal funds can be utilized for purchase of ROW for these types of projects.

<u>Sale of ROW: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate: Section §710.409</u>

23 CFR §710.409 deals with the disposal of real property interest that is deemed in excess to transportation needs. Under §710.409 (a) real property can be sold or conveyed to a public entity or a private party. Sub-section (b) requires that Federal, State, and local agencies shall be given an opportunity to acquire property that shall be disposed where the interest has potential use for parks, conservation, recreational or other related purposes, and wherein state law allows such a transfer. The State DOT is required to notify the appropriate resource agencies regarding the disposal intention. This can be accomplished through placing of the notice in the state's regular disposal notification listing.

Sub-section (c) allows the DOT to retain excess property to restore, preserve, or improve the scenic beauty, and environmental quality adjacent to the transportation facility. If a property is transferred at less than fair market value for a public purpose interest that is approved by the FHWA, sub-section (d) requires that the deed provides for the property to revert back to the DOT for failure to continue public ownership and use. If the property is sold at a fair market value no reversion clause is required. Under this section any disposal activity described in 23 CFR §710.403(d)(1) for less than fair market value require a public interest determination and the FHWA approval consistent with that section.

Comment: Under federal statute there is latitude for TxDOT to consider implementing some VEAs – permanent or temporary – and for proceeds to be used for activities that are eligible under Title 23 CFR funding provisions.

Federal Statute: Utility Guidance

Guidance on the accommodation of utilities in ROW can be found in both federal and state codes, and TxDOT's ROW manual. At the federal level, 23 CFR governs utility accommodation policy in Sub-chapter G Engineering and Traffic Operations at Part 645 Utilities, and also in 23 CFR Sub-chapter H Right of Way and Environment at Part 710. The American Association of State Highway Officials (AASHTO) also played a pivotal role in the development of a national policy regarding utility accommodation and installations on freeways throughout the 1950s, 60s, and 70s. In Texas, Transportation Code, Utilities Code, and Administrative Code govern how utilities can be accommodated within ROW. It is assumed for the purpose of this technical memorandum that utilities could also include production from solar and wind components, as well as transmission lines needed to connect the production components with the electricity grid.

In TxDOT research project 0-6455 it was noted that longitudinal access for utilities on DOT ROW became a more standard practice in the latter part of the twentieth century. Both the FHWA and TxDOT had developed regulations and guidance for such accommodation. Over the past 2 to 3 years, many requests have also come into the FHWA regarding the longitudinal accommodation of transmission infrastructure associated with renewable energy technologies. As a consequence the FHWA issued guidance in 2009 on "Longitudinal Accommodation of Utilities from Renewable Energy Facilities" (FHWA, 2009).

Utility Accommodation: 23 CFR Part 645B

23 CFR Sub-chapter G Engineering and Traffic Operations Part 645 outlines policies for accommodating utility facilities and private lines in the ROW of federal aid or direct federal highway projects. Section 645.203 applies to new utility installations. Section 645.205 (a) notes that it is in the *public interest* for utility facilities to be accommodated in the ROW of federal highways as long as such use and occupancy of the ROW *does not adversely affect highway or traffic safety or its aesthetic quality*. Section 645.205 (b) notes that by tradition and practice highway and utility facilities have frequently coexisted within common ROW or along the same corridors and that this practice *is essential* for these public service facilities to be *compatibly designed and operated*. In the design of new highway facilities consideration should be given to the utility service needs of the area traversed if the service is provided by utility facilities on or near the highway. Joint highway and utility planning is encouraged for federal highway projects.

However, the section also provides in §645.209 (3) that states are not precluded from adopting more restrictive policies with regard to longitudinal utility installations along ROW. Regarding the provision of private lines under §645.209 (e), state DOTs are required to establish uniform policies for controlling such permitted use. Longitudinal installations must conform with 23 CFR §1.23(c). For scenic areas, new utility installations are not permitted in highway ROW or on other lands except in a few circumstances, which include:

- aerial installations where placement underground is not technically feasible,
- other locations are not available, or are unusually difficult or costly, or are less desirable from the standpoint of aesthetic quality, and

- the proposed installation will be made at a location, and will employ suitable designs and materials, which give the greatest weight to the aesthetic qualities of the area being traversed.[11]

Section 645.211 lays out the accommodation policies and requires that consideration shall be given to the effect of utility installations on to *safety, aesthetic quality, and costs or difficulty of highway and utility construction and maintenance.* Section 645.211 (c) outlines standards for regulating use and occupancy of ROW. Sub-section (5) allows a DOT to deny a utility's request to occupy ROW based on state law, regulation, local ordinances or the DOT's utility policy. However, where these provisions are cited as the basis for disapproving a utility's request to use and occupy ROW, measures *must be provided to evaluate the direct and indirect environmental and economic effects of any loss of productive agricultural land or any impairment of the productivity of any agricultural land that would result from the disapproval*. The environmental and economic effects on productive agricultural land together with the possible interference with or impairment of the use of the highway and the effect on highway safety must thus be considered in the decision to disapprove any proposal by a utility to use such highway ROW.

Section 645.211 (e) requires DOTs to include in their utility accommodation plan, the detailed procedures, criteria, and standards it will use to evaluate and approve individual applications for utilities on freeways under the provisions of §645.209(c) of this part. DOTs may develop such procedures, criteria, and standards by class of utility. In defining utility classes, consideration may be given to distinguishing utility services by type, nature or function, and their potential impact on the highway and its user. Section 645.211 (f) notes that the means and authority for enforcing the control of access restrictions applicable to utility use of controlled access highway facilities should be clearly set forth in the DOTs utility accommodation plan.

Under Section 645.215 (a) states are required to submit a statement to the FHWA on (a) the authority of utilities to use and occupy ROW; (b) the department's power to regulate this use and identification of any areas on the federal aid highways where the DOT is without legal authority to regulate use by utilities, and (c) any policies and procedures that the DOT employs to facilitate accommodation of utilities within the ROW of federal aid highways. Once the FHWA determines that the DOT's policies meet the requirements and satisfies provisions of 23 CFR §1.23 and §1.27. it can then approve their use on Federal-aid highway projects in that State.

Comment: These sections provide TxDOT with opportunities to accommodate utility activities along an existing interstate. This could ensure that other pristine locations or productive agricultural lands are not traversed by utility facilities or transmission lines, which would allow this land to be preserved for agricultural or other uses for future generations. It also provides an element of latitude to put utility transmission in ROW from the Competitive Renewable Energy Zones (CREZ) designated in Texas, instead of requiring them to utilize agricultural or scenic property. It would also allow TxDOT – if it so chose to do – to develop a more prescriptive policy approach for accommodation of renewable transmission opportunities.

11 Suitable designs include, but are not limited to, self-supporting armless, single-pole construction with vertical configuration of conductors and cable (§645.209 (h) (1 - through iii).

FHWA 2009 Utility Accommodation Longitudinal Guidance

In 2009 the FHWA released guidance on longitudinal accommodation of utilities in the interstate system ROW. This was as a consequence of the emerging interest in the production and distribution of renewable energy and proposals that were coming into the states to locate such facilities in highway ROW. The guidance describes steps to determine whether the accommodation should be conducted under 23 CFR Part 645 Subpart B or 23 CFR Part 710.

The guidance encouraged states to review their accommodation policies and make updates and modifications to consider renewable energy and other items outlined in the memo. The guidance is intended to complement the FHWA's 6th Edition of the Program Guide: Utility Relocation and Accommodation on Federal-Aid Highway Projects released in January 2003 (FHWA, 2003), but notes that much of the discussion contained in the document is *considered applicable to other freeways and similar transportation facilities.* The guidance provides steps to determine whether the facility serves the public and meets the definition of utility and can thus be accommodated under 23 CFR 645 Subpart B.

The guidance in reviewing other longitudinal accommodation considerations, notes that other federal policies, laws, regulations, and standards may come into play in the decision making process. One area that is discussed is planning. Noting that U.S.C 134, 135, and 23 CFR 450 established the FHWA requirements for statewide and metropolitan transportation planning, the guidance goes on to say that while utility interests are not explicitly addressed in the regulations, it is nevertheless *appropriate to include a utility element in the undertaking of a multimodal, systems-level corridor or subarea planning study or in the development of the long-range statewide and or/metropolitan transportation plan*. Discussions in these documents, the memo concedes would supplement, rather than supplant, the information contained in utility accommodation policies. The FHWA encourages coordination with utility interests in a strategic planning process that identifies roles and responsibilities of the DOT in the accommodation of longitudinal utility facilities within the ROW of the interstate system. Specific proposals for longitudinal installation along the interstate system could then be evaluated for compatibility with applicable metropolitan or statewide long-range transportation plans.

The FHWA *encourages* DOT's in this memo to include in their policy discussion of how utility accommodation can be *better integrated into their transportation planning process at the state, regional, and corridor levels*. This focus would place states in a better position to handle accommodation questions systematically rather than on a case-by-case basis. The memo also encourages FHWA Division staff to

- work with DOTs to integrate consideration of utility facilities in statewide strategic plans, highway system metropolitan transportation plans and corridor transportation plans.
- work with their DOTs to conduct a review and assessment of the DOT's utility accommodation plan to ensure it adequately meets current needs.

Comment: Given the policy focus of this guidance, there is latitude for the states to program for the installation and accommodation of utilities, which could include generation assets such as turbines or solar panels (especially to achieve RPS goals) within their transportation planning activities.

Federal Highway Beautification Controls

Another area that must be taken into consideration when reviewing VEAs in the ROW is federal and state law regarding highway beautification, which restricts outdoor advertising and displays and devices adjacent to the highway system. This issue could come into play where the DOT may partner with an entity who may want to place a sign to advertise the partnership or the specific VEA that is being developed. Such a sign will have to fall within the series of classes (1 to 4) permitted by the FHWA. TxDOT will also need to be cognizant that the actual application itself does not fall foul of the provisions within the highway beautification act. For example, TxDOT needs to ensure that no stray light or light movement are visible, or that the VEA does not have any moving parts.

In 1959, the US Congress passed the Federal-Aid Highway Act of 1958 (Pub. L. 85–381, 72 Stat. 95) where Congress declared that:

(1) To promote the safety, convenience, and enjoyment of public travel and the free flow of Interstate commerce and to protect the public investment in the National System of Interstate and Defense Highways, hereinafter called the Interstate System, it is in the public interest to encourage and assist the States to control the use of and to improve areas adjacent to such system by controlling the erection and maintenance of outdoor advertising signs, displays, and devices adjacent to that system.

(2) *It is a national policy that the erection and maintenance of outdoor advertising signs, displays, or devices within 660 feet of the edge of the ROW and visible from the main-traveled way of all portions of the Interstate System constructed upon any part of ROW, the entire width of which is acquired subsequent to July 1, 1956, should be regulated, consistent with national standards to be prepared and promulgated by the Secretary of Transportation.*

<u>23CFR Part 750—Highway Beautification</u>

23 CFR Sub-chapter H Right of Way and Environment Part 750 Highway Beautification, Section 750.102 provides terms to be used in the standards of this part and includes definitions that underlie the act including what acquired ROW means, and how to measure the centerline of the highway. A definition for an informational site and the protected area i.e., all areas inside the boundaries of a , which are adjacent to and within 660 feet of the edge of the ROW of all controlled portions of the Interstate System within that State – is also provided. Where a controlled portion of the Interstate System terminates at a State boundary, which is not perpendicular or normal to the centerline of the highway, protected areas also means all areas inside the boundary of such State, which are within 660 feet of the edge of the ROW of the Interstate Highway in the adjoining State (750.102 (k)).

For the purposes of this sub-section Section 750.102 (k) (1)) *Scenic area* means any public park or area of particular scenic beauty or historical significance designated by or pursuant to State law as a scenic area. Under Section 750.102 (m) *Sign* means any outdoor sign, display, device, figure, painting, drawing, message, placard, poster or billboard, which is designed, intended, or used to advertise or inform, as well as any part of the advertising or informative contents that is visible from any place on the main-traveled way of a controlled portion of the Interstate System. The precise measurement of the distance guidance can be found in Section 750.103. Distance is measured horizontally along a line that is normal or perpendicular to the centerline of the highway.

Permitting and Erecting of Signs in Protected Areas: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate Section 750.104

Section 750.104 restricts the permitting or erection of signs in certain protected areas. These include signs that are illegal under state or federal laws that are in effect at the location of such signs or activities, obsolete signs, signs that are not clean and in good repair, not securely affixed to a substantial structure, and not consistent with standards laid out in this part of the regulations. Section 750.105 prescribes signs that are permitted in protected areas. Table I.1 provides the definitions of these various classes of signs.

Table I.1: Classes of Signs

<table>
<tr><th>Class 1: Official Signs</th><th>Class 3: Signs within 12 miles of advertised activities</th></tr>
<tr><td>Directional or other official signs or notices erected and maintained by public officers or agencies pursuant to and in accordance with direction or authorization contained in State or Federal law, for the purpose of carrying out an official duty or responsibility.</td><td>Signs not prohibited by State law, which are consistent with the applicable provisions of this section and §§750.106, 750.107, and 750.108 and which advertise activities being conducted within 12 air miles of such signs.</td></tr>
<tr><th>Class 2: On-Premise signs</th><th>Class 4: Signs in Specific interest of travelling public</th></tr>
<tr><td>Signs not prohibited by State law, which are consistent with the applicable provisions of this section and §750.108 and which advertise the sale or lease of, or activities being conducted upon, the real property where the signs are located. Not more than one such sign advertising the sale or lease of the same property may be permitted under this class in such manner as to be visible to traffic proceeding in any one direction on any one Interstate Highway. Not more than one such sign, visible to traffic proceeding in any one direction on any one Interstate Highway and advertising activities being conducted upon the real property where the sign is located, may be permitted under this class more than 50 feet from the advertised activity.</td><td>Signs authorized to be erected or maintained by State law, which are consistent with the applicable provisions of this section and §§750.106, 750.107, and 750.108 and which are designed to give information in the specific interest of the traveling public.</td></tr>
<tr><td colspan="2">(b) A Class 2 or 3 sign, except a Class 2 sign not more than 50 feet from the advertised activity, that displays any trade name, which refers to or identifies any service rendered or product sold, used, or otherwise handled more than 12 air miles from such sign may not be permitted unless the name of the advertised activity, which is within 12 air miles of such sign is displayed as conspicuously as such trade name.
(c) Only information about public places operated by Federal, State, or local governments, natural phenomena, historic sites, areas of natural scenic beauty or naturally suited for outdoor recreation and places for camping, lodging, eating, and vehicle service and repair is deemed to be in the specific interest of the traveling public. For the purposes of the standards in this part, a trade name is deemed to be information in the specific interest of the traveling public only if it identifies or characterizes such a place or identifies vehicle service, equipment, parts, accessories, fuels, oils, or lubricants being offered for sale at such a place. Signs displaying any other trade name may not be permitted under Class 4.
(d) Notwithstanding the provisions of paragraph (b) of this section, Class 2 or Class 3 signs which also qualify as Class 4 signs may display trade names in accordance with the provisions of paragraph (c) of this section.</td></tr>
</table>

Section 750.106 provides standards for Class 3 and 4 signs that are within informational sites. Under this section informational sites for the erection and maintenance of these classes of advertising signs, can be established in accordance with §1.35 of this chapter. The location and frequency of these sites are determined by agreements between the State DOTs and the Secretary of Transportation (Secretary), which are consistent with the following provisions (750.106 (a)):

1. No sign may be permitted which is not placed upon a panel.
2. No panel may be permitted to exceed 13 feet in height or 25 feet in length, including border and trim, but excluding supports.
3. No sign may be permitted to exceed 12 square feet in area, and nothing on such sign may be permitted to be legible from any place on the main-traveled way or a turning roadway.
4. Not more than one sign concerning a single activity or place may be permitted within any one informational site.
5. Signs concerning a single activity/place are permitted within more than one informational site, but no Class 3 sign, which does not also qualify as a Class 4 sign, may be permitted within any informational site more than 12 air miles from advertised activity.
6. No sign may be permitted, which moves or has any animated or moving parts.
7. Illumination of panels by other than white lights may not be permitted, and no sign placed on any panel may be permitted to contain, include, or be illuminated by any other lights, or any flashing, intermittent, or moving lights.
8. No lighting may be permitted to be used in any way in connection with any panel unless it is so effectively shielded as to prevent beams or rays of light from being directed at any portion of the main-traveled way of the Interstate System, or is of such low intensity or brilliance as not to cause glare or to impair the vision of the driver of any motor vehicle, or to otherwise interfere with any driver's operation of a motor vehicle.

Section 750.107 provides standards for Class 3 and 4 signs that are outside informational sites but within protected areas. No Class 3 or 4 signs other than those permitted by this section may be erected or maintained within protected areas outside informational sites. The standards that must be adhered to under paragraph (a) require:

1. Class 3 signs, which are visible only to Interstate highway traffic not served by an informational site within 12 air miles of the advertised activity;
2. Class 4 signs, which are more than 12 miles from the nearest panel within an informational site serving Interstate highway traffic to which such signs are visible; and
3. Signs that qualify both as Class 3 and 4 signs may be permitted in accordance with either paragraph (a)(1) or (2) of this section.

The erection or maintenance of signs permitted under paragraph (a) of this section may not be permitted in any manner inconsistent with the following provisions:

1. In protected areas in advance of an intersection of the main-traveled way of an Interstate highway and an exit roadway, such signs visible to Interstate highway traffic approaching such intersection may not be permitted to exceed the following number:

Table I.2: Number of Signs allowed at intersections

Distance from Intersection	Number of Signs
0-2 miles	0
2-5 miles	6
More than 4 miles	Average of 1 sign per mile
The specified distances shall be measured to the nearest point of the intersection of the traveled way of the exit roadway and the main-traveled way of the Interstate highway.	

2. Subject to the other provisions of this paragraph, not more than two such signs may be permitted within any mile distance measured from any point, and no such signs may be permitted to be less than 1,000 feet apart.
3. Such signs may not be permitted in protected areas adjacent to Interstate highway ROW upon any part on the width of which is constructed an entrance or exit roadway is constructed.
4. Such signs visible to Interstate highway traffic, which is approaching or has passed an entrance roadway, may not be permitted in protected areas for 1,000 feet beyond the furthest point of the intersection between the traveled way of such entrance roadway and the main-traveled way of the Interstate highway.
5. No such signs may be permitted in scenic areas.
6. Not more than one such sign advertising activities being conducted as a single enterprise or giving information about a single place may be erected or maintained in such manner as to be visible to traffic moving in any one direction on any one Interstate highway.

In Section 750.108 general provisions are laid out for this sub-section for Class 3, 4 and for Class 2 signs. Here no Class 3 or 4 signs may be permitted to be erected or maintained pursuant to §750.107, and no Class 2 sign may be permitted to be erected or maintained, in any manner inconsistent with the following:

a) No sign is permitted which attempts or appears to attempt to direct movement of traffic or which interferes with, imitates, or resembles any official traffic sign(al) or device.

b) No sign may be permitted which prevents the driver of a vehicle from having a clear and unobstructed view of official signs and approaching or merging traffic.

c) No sign may be permitted which contains, includes, or is illuminated by any flashing, intermittent or moving light or lights.

d) No lighting may be permitted to be used in any way in connection with any sign unless it is so effectively shielded as to prevent beams or rays of light from being directed at any portion of the main-traveled way of the Interstate System, or is of such low intensity or brilliance as not to cause glare or to impair the vision of the driver of any motor vehicle, or to otherwise interfere with any driver's operation of a motor vehicle.

e) No sign may be permitted which moves or has any animated or moving parts.

f) No sign may be permitted to be erected or maintained upon trees or painted or drawn upon rocks or other natural features.

g) No sign may be permitted to exceed 20 feet in length, width or height, or 150 square feet in area, including border and trim but excluding supports, except Class 2 signs not more than 50 feet from, and advertising activities being conducted upon, the real property where the sign is located.

The one exclusion for this part is that it does not apply to markers, signs, and plaques in appreciation of sites of historical significance where an agreement has been made between the State and the Secretary of Transportation, unless such agreement expressly makes all or any part of the standards applicable (750.109). Section 750.110 allows the states to elect to prohibit signs permissible under the standards in this part without forfeiting its rights to any benefits provided for in the act.

<u>Directional and Official Signs: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate Section 750.153</u>

Sub-part B Sections 750.153 and 750.154 outline national standards for directional and official signs. These were developed to protect the public investment in highways, promote safety and recreational value of public travel, and preserve *natural beauty* (Section 750.151 (a) (1)). Sub-section 2 provides that directional and official signs and notices, shall include, but not be limited to, signs and notices pertaining to natural wonders, and scenic and historical attractions, and as required or authorized by law. These signs must conform to national standards regarding lighting, size, number, and spacing. Section 750.152 delineates the national standards that apply to directional and official signs located within 660 feet of the ROW of the interstate and federal-aid primary systems, and to signs located beyond 660 feet outside of urban areas, visible from the main travel way, developed to be read from the main travelled way. These standards do not apply to directional and official signs erected on the highway ROW. Section 750.153 sets out definitions for signs under this part (See Table I.3).

Table I.3: Definitions for Directional and Official Signs

Sign means an outdoor sign, light, display, device, figure, painting, drawing, message, placard, poster, billboard, or other thing which is designed, intended, or used to advertise or inform, any part of the advertising or informative contents of which is visible from any place on the main traveled way of the Interstate or Federal-aid primary highway.
Main traveled way means the through traffic lanes of the highway, exclusive of frontage roads, auxiliary lanes, and ramps. *Freeway* means a divided arterial highway for through traffic with full control of access.
Interstate System means the National System of Interstate and Defence Highways described in section 103(d) of title 23 U.S.C and *Primary system* means the Federal-aid highway system described in section 103(b) of title 23 U.S.C.
Erect means to construct, build, raise, assemble, place, attach, create, draw, or in any other way bring into being or establish.
Scenic area means any area of particular scenic beauty or historical significance determined by the Federal, State, or local officials having jurisdiction, and includes land acquired for the restoration, preservation, and enhancement of scenic beauty.
Parkland means any publicly owned land which is designated or used as a public park, recreation area, wildlife or waterfowl refuge or historic site.
Visible means capable of being seen (whether or not legible) without visual aid by a person of normal visual acuity.
Rest area means an area or site established and maintained within or adjacent to the highway ROW by or under public supervision or control for the convenience of the traveling public.
Directional and official signs and notices includes only official signs and notices, public utility signs, service club and religious notices, public service signs, and directional signs.
Official signs and notices means signs and notices erected and maintained by public officers or public agencies within their territorial or zoning jurisdiction and pursuant to and in accordance with direction or authorization contained in Federal, State, or local law for the purposes of carrying out an official duty or responsibility. Historical markers authorized by State law and erected by State or local government agencies or nonprofit historical societies may be considered official signs.
Public utility signs means warning signs, informational signs, notices, or markers which are customarily erected and maintained by publicly or privately owned public utilities, as essential to their operations.
Service club and religious notices means signs and notices, whose erection is authorized by law, relating to meetings of nonprofit service clubs or charitable associations, or religious services, which signs do not exceed 8 square feet in area.
Public service signs means signs located on school bus stop shelters, which signs: o Identify the donor, sponsor, or contributor of said shelters; o Contain public service messages, which shall occupy not less than 50 percent of the area of the sign; o Located on school bus shelters authorized or approved by city, county, or State law, regulation, or ordinance, and at places approved by the city, county, or State agency controlling the highway involved; and o May not exceed 32 square feet in area. Not more than one sign on each shelter shall face in any one direction.
Directional signs means signs containing directional information about public places owned or operated by Federal, State, or local governments; publicly or privately owned natural phenomena, historic, cultural, scientific, educational, and religious sites; and areas of natural scenic beauty or naturally suited for outdoor recreation, deemed to be in the interest of the traveling public.
Urban area means an urbanized area or, in the case of an urbanized area encompassing more than one State, that part of the urbanized areas in each such State, designated by the Bureau of the Census having a population of five thousand or more and not within any urbanized area, within boundaries to be fixed by State and local officials in cooperation, subject to approval by the Secretary. Such boundaries shall, as a minimum, encompass the entire urban place designated by the Bureau of the Census.

Standards for Directional Signs 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate Section 750.154

Section 750.154 sets out the standards for directional signs. Prohibited signs include:

- Signs advertising illegal activities or regulations in effect at the location of those signs or at the location of those activities.

- Signs located in such a manner as to obscure or otherwise interfere with the effectiveness of an official traffic sign, signal, or device, or obstruct or interfere with the driver's view of approaching, merging, or intersecting traffic.
- Signs erected or maintained upon trees or painted/drawn upon rocks/natural features.
- Obsolete signs.
- Signs which are structurally unsafe or in disrepair.
- Signs which move or have any animated or moving parts.
- Signs located in rest areas, parklands, or scenic areas.

Signs cannot exceed the size specified in Figure I.1, including border and trim, but excluding supports.

Figure I.1: Sign Dimensions

Signs may be illuminated, subject to the following:

1. Signs that contain, include, or are illuminated by any flashing, intermittent, or moving light or lights are prohibited.
2. Signs that are not effectively shielded so as to prevent beams or rays of light from being directed at any portion of the traveled way of an Interstate or primary highway or that are of such intensity or brilliance as to cause glare or to impair the vision of the driver of any motor vehicle, or that otherwise interfere with any driver's operation of a motor vehicle are prohibited.
3. No sign may be so illuminated as to interfere with the effectiveness of or obscure an official traffic sign, device, or signal.

Location of a directional sign must be approved by the DOT. No directional sign may be located within 2,000 feet of an interchange, or intersection at grade along the Interstate System or other freeways. The distance is measured along the Interstate or freeway from the nearest point of the beginning or ending of pavement widening at the exit from or entrance to the main traveled way. Nor can a directional sign be located within 2,000 feet of a rest area, parkland, or scenic area. No two directional signs facing the same direction of travel shall be spaced less than 1 mile apart and not more than three directional signs pertaining to the same activity and facing the same direction of travel may be erected along a single route approaching the activity. Signs located adjacent to the Interstate System shall be within 75 air miles of the activity; and signs located adjacent to the primary system shall be within 50 air miles of the activity.

The content of the message on directional signs is restricted to the identification of the attraction or activity and any directional information that will be useful for the traveler to locate this activity. This can include, for example, mileage, route, or exit numbers. Descriptive words/phrases, and any pictorial or graphical type representation is prohibited. For privately owned attractions or activities, the directional signing is limited to natural phenomena; scenic attractions; historic, educational, cultural, scientific, and religious sites; and outdoor recreational areas. These attractions must also be regionally or nationally known, and of outstanding public interest for them to be eligible.

States were required to develop specific selection methods and criteria to be used in determining whether or not an activity qualifies for this type of signing. Section 750.155 allowed the states to establish and maintain standards that are more restrictive with respect to directional and official signs and notices along the Federal-aid highway systems than the national standards.

Sub-part(s) D and E Sections 750.301 through 750.308 and 750-501 through 750.503 sets out provisions for federal participation in the cost of acquiring property interests necessary for removal of nonconforming advertising signs, displays/devices on Federal-aid Primary and Interstate Systems, regardless of whether federal funds participated in their construction; as well as procedures for states to seek exemptions for directional or information signs.

<u>Outdoor Advertising Control: 23 CFR Sub-chapter H – Right of Way and Environment: Part 710 Right of Way and Real Estate Section 750.701</u>

Section 750.701 prescribes FHWA requirements relating to the control of outdoor advertising. The purpose of these requirements is to assure effective State control of outdoor advertising in areas adjacent to Interstate and Federal-aid primary highways. States are allowed under this subpart to establish more stringent outdoor advertising control requirements along Interstate and Primary Systems than provided herein. These provisions are applicable to all areas adjacent to the interstate and primary systems except that within urban areas, these provisions apply only within 660 feet of the nearest edge of the ROW. The provisions do not apply to the Federal-aid Secondary or Urban Highway Systems.

Table I.4: Definitions for Outdoor Advertising Control

Commercial and Industrial zones are districts established by zoning authorities for commerce, industry, or trade. They are commonly categorized as commercial, industrial, business, manufacturing, highway service or highway business (intended for highway-oriented business), retail, trade, warehouse, and similar classifications.
Lease means an agreement, license, permit, or easement, oral or in writing, by which possession or use of land or interests therein is given for a specified purpose, and which is a valid contract under the laws of a State. *Main-traveled way* means the traveled way of a highway on which through traffic is carried. In the case of a divided highway, the traveled way of each of the separate roadways for traffic in opposite directions is a main-traveled way. It does not include frontage roads, turning roadways, or parking areas.
Sign, display or device, hereinafter referred to as "sign," means an outdoor advertising sign, light, display, device, figure, painting, drawing, message, placard, poster, billboard, or other thing which is designed, intended, or used to advertise or inform, any part of the advertising or informative contents of which is visible from any place on the main-traveled way of the Interstate or Primary Systems, whether the same be permanent or portable installation.
Unzoned area means an area where there is no zoning in effect. It does not include areas which have a rural zoning classification or land uses established by zoning variances or special exceptions.
Unzoned commercial or industrial areas are unzoned areas actually used for commercial or industrial purposes as defined in the agreements made between the Secretary, and each State pursuant to 23 U.S.C. 131(d).
Visible means capable of being seen, whether or not readable, without visual aid by a person of normal visual acuity.

Section 750.704 stipulates that signs that are adjacent to the interstate and Federal-aid Primary Systems which are visible from the main-traveled way and within 660 feet of the nearest edge of the ROW, and those additional signs beyond 660 feet outside of urban areas, which are visible from the main-traveled way and erected with the purpose of their message being read from such main-traveled way, shall be limited to the following:

(1) Directional and official signs and notices shall conform to national standards promulgated by the Secretary in subpart B, part 750, chapter I, 23 CFR, National Standards for Directional and Official Signs;

(2) Signs advertising the sale or lease of property upon which they are located;

(3) Signs advertising activities conducted on the property on which they are located;

(4) Signs within 660 feet of the nearest edge of the ROW within areas adjacent to the Interstate and Federal-aid Primary Systems, which are zoned industrial or commercial under the authority of State law;

(5) Signs within 660 feet of the nearest edge of the ROW within areas adjacent to the Interstate and Federal-aid Primary Systems that are unzoned commercial or industrial areas, as determined by agreement between the State and the Secretary; and

(6) Signs lawfully in existence on October 22, 1965, which are determined to be landmark signs.

Outdoor advertising signs are required to comply with the size, lighting, and spacing requirements that are determined by the State and the Secretary. 23 U.S.C. 131 does not permit signs to be located within zoned or unzoned commercial or industrial areas beyond 660 feet of the ROW adjacent to the Interstate or Federal-aid Primary System, outside of urban areas. 23 U.S.C. 131 requires signs not permitted under §750.704 of this regulation be removed by the State.

States are required under 750.705 to prohibit the creation of new signs (other than those that fall within Section 750.404 (a) (1) through (6) discussed above). States are also required to assure that signs erected under 750.704 (a)(4 and 5) comply with size, lighting, and spacing criteria and that signs erected under 750.704 (a) (1) comply with the national standards contained in subpart B, part 750, chapter I, 23 CFR. Illegal signs must be removed expeditiously and nonconforming signs must be removed with just compensation provided within the time period set by 23 U.S.C. 131 subpart D, part 750, chapter I, 23 CFR, sets forth policies for the acquisition and compensation for such signs. States are also required to establish criteria for determining which signs have been erected with the purpose of their message being read from the main-traveled way of an Interstate or primary highway, except where State law makes such criteria unnecessary. Where a sign is erected with the purpose of its message being read from two or more highways – one or more of which is a controlled highway – the more stringent of applicable control requirements apply.

Sub-section 750.706 sets the requirements for signs located in zoned and unzoned commercial and industrial areas within 660 feet of the nearest edge of the ROW adjacent to the Interstate and Federal-aid primary highways. States are required to set by law or regulation that was in conformity with the Secretary criteria for size, lighting, and spacing of outdoor advertising signs located in these zones. The sub-section allows States to adopt more restrictive criteria. Under this agreement, criteria that permit multiple sign structures to be considered as one sign for spacing purposes must limit multiple sign structures to signs that are physically contiguous, or connected by the same structure or cross-bracing, or located not more than 15 feet apart at their nearest point in the case of back-to-back or “V” type signs.

Sub-section750.706 (c) notes that where the agreement and State law permits control by local zoning authorities, these controls may govern in lieu of the size, lighting, and spacing controls set forth in the agreement, subject to the following:

- The local zoning authority's controls must include the regulation of the size, lighting, and spacing of outdoor advertising signs, in all commercial and industrial zones.
- The regulations established by the local zoning authority may be either more restrictive or less restrictive than the criteria contained in the agreement, unless State law or regulations require equivalent or more restrictive local controls.
- If the zoning authority has been delegated, extraterritorial jurisdiction under State law comes into play. If the local zoning authority exercises control of outdoor advertising in commercial and industrial zones within this extraterritorial jurisdiction, control by the zoning authority may be accepted in lieu of agreement controls in such areas.
- The State shall notify the FHWA where local control applies. It is not necessary to supply copies of ordinances. The State shall periodically assure itself that the size, lighting, and spacing control provisions of zoning ordinances accepted under this section are actually being enforced by the local authorities.
- However, even if the local jurisdiction exercises these local zoning controls, the State is not relieved of the responsibility of limiting signs within controlled areas to commercial and industrial zones.

The provisions of §750.707 apply to nonconforming signs that must be removed under State laws and regulations. These provisions also apply to nonconforming signs located in commercial and industrial areas within 660 feet of the nearest edge of the ROW, which come under the so-called grandfather clause contained in State-Federal agreements.

Section 750.708 sets out the parameters for acceptance of state/local zoning laws. 23 U.S. C 131 (d) provides that signs "may be erected and maintained within 660 feet of the nearest edge of the ROW within areas . . . which are *zoned industrial or commercial* under authority of State law." As States have full authority under their zoning laws to zone areas for commercial or industrial purposes, actions by States in this regard will be accepted for the purposes of this Act. State and local zoning actions will be taken pursuant to the enabling statute or any constitutional authority. Actions that are not part of comprehensive zoning, or are created specifically to permit outdoor advertising structures are not recognized as zoning for outdoor advertising control purposes. If a local government has not zoned in accordance with the state statutory authority, it is not authorized to zone. The definition of an unzoned commercial or industrial area under the parameters of the State-Federal Agreement would then apply to this political subdivision or area. Even if commercial or industrial activities are permitted as an *incident* to the other primary land uses in this area, it is not considered to be a commercial/industrial zone for advertising control purposes.

Section 750.709 governs on-property or on-premise advertising. Signs that solely consist of the name of the establishment or establish its principal or accessory products/services is an on-property sign (§750.709 (a)). If a sign principally consists of brand name or trade name advertising and this advertised product or service *is only incidental* to the principal activity, or if it brings rental income to the property owner, it shall be considered the business of outdoor advertising and not an on-property sign. Section 750.709 (c) finds that a sale or lease sign, which also advertises a product or service not conducted upon and unrelated to the business or selling or leasing of the land on which the sign is located, is not an on-property sign.

Signs that are exempt from control of 23 U.S.C. 131 include those that solely advertise the sale or lease of property on which they are located or advertise activities conducted on the property on which they are located. These signs are subject to regulation (subpart A, part 750, chapter I, 23 CFR) in those States that have executed a bonus agreement, 23 U.S.C. 131(j). State laws or regulations shall contain criteria for determining exemptions. These may include:

- A property test for determining whether a sign is located on the same property as the activity or property advertised.
- A purpose test for determining whether a sign has as its sole purpose the identification of the activity located on the property or its products or services, or the sale or lease of the property on which the sign is located.

The criteria must be sufficiently specific to curb attempts to improperly qualify outdoor advertising as "on-property" signs. For example, prohibit signs on narrow strips of land contiguous to the advertised activity when the purpose is clearly to circumvent 23 U.S.C. 131.

Under Section 750.710 landmark signs are permitted that were in existence before October 22, 1965 and where the State, with Secretary approval, determines they are landmark signs including, signs that are on natural surfaces or farm structures, or are of artistic or historical significance and where preservation is consistent with 23 U.S. 131. Within this section reasonable maintenance, repair, and restoration is permitted. However, substantial changes in lighting, size, or message content will terminate this status (750.710 (c)).

Section 750.711 governs structures that have never displayed advertising material. This includes poles, which have never displayed advertising or informative content. These are subject to control and/or removal when advertising content is affixed and it becomes visible from the main-traveled way. On this occurrence an outdoor advertising sign will be considered to have been erected, that must comply with the state law in effect. Signs may be reclassified under 750.712 from legal-conforming to nonconforming (and be subject to removal). If this occurs, they will be eligible for just compensation payment when removed.

Comment: The federal and state programs for highway beautification also provide models for how the DOT may want to implement certain VEAs. This could be viewed in terms of how to administer the application, the type of fees that could be set, other administrative provisions, and penalties for violation. From the state's perspective, the state program for signs and outdoor advertising provides an elementary model for how TxDOT could consider implementing some of the VEAs in partnership with other jurisdictions and the private sector.

Texas ROW Control, Use, Management, Modernization, and Acquisition: Statute Review

General Provisions and Administration

Texas Transportation Code (TC) Chapter 201 lays out the general provisions and administration by TxDOT for Roadways. Sub-chapter B describes the composition of the Texas

Transportation Commission (Commission), and lays out in Section 201.0545 the role of Commission in considering ways in to improve the department's operations and provides the Commission with the ability to recommend to the legislature potential statutory changes necessary to implement the recommended operational improvements.

Sub-chapter C sets out the Commission's powers and duties in Sub-section 201.1055. The department and a private entity that offers the best value can enter into agreements for:

- Acquisition, design, and construction or renovation, which includes site development of facilities and buildings required to *support department operations* located on real property owned or acquired by the department.
- Acquisition from a private entity of real property, including a building or other facility to *support department operations*, that is constructed on the real property in exchange for department-owned real property. This includes any improvements.

Projects in this section if not wholly paid for by a property exchange can be financed in accordance with the provision of Section 1232.111 Government Code.

Under Section 201.1055 (c) notwithstanding Section 202.024, the commission may authorize the director to exchange department-owned real property under Sub-section (a)(2). Section 201.1055 (d) requires that the commission shall notify the Bond Review Board and Texas Public Finance Authority of the proposed transaction not less than 45 days before the date the commission signs an agreement under this section providing for the exchange of department-owned real property under Sub-section (a)(2). The agreement for the exchange of department-owned real property under Sub-section (a)(2) that has an appraised value greater than the appraised value of real property and improvements acquired by the department under the agreement, must require the private entity to compensate the department for the difference. Any compensation paid by a private entity must be deposited to the credit of the state highway fund and is exempt from the application of Section 403.095, Government Code 201.1055 (e).

Provision for Hydrogen-Fueled Vehicles and Refueling Stations

In 2005, the legislature added to TC Title 6, Section 201.618 whereby the department may seek funding from public and private sources to acquire and operate hydrogen-fueled vehicles and to establish and operate *hydrogen refueling stations* as provided by this section. If funding is acquired, the department can establish and operate at least five hydrogen refueling stations. A refueling station established under this sub-section must be located in an *urbanized area along a major state highway and be accessible to the public.* Section 201.618 (c)) allows the department, subject to securing funding, to purchase and operate – in an area in which a refueling station is established – vehicles capable of operating on hydrogen, including, at a minimum:

- four vehicles with internal combustion engines that run on hydrogen; and
- three fuel-cell vehicles, and one internal combustion engine bus that runs on hydrogen or one fuel-cell bus.

201.618 (d) requires that a vehicle purchased to meet the requirements of sub-section (c) may be used to satisfy the *alternative fuels percentage* requirement under Sub-chapter A, Chapter 2158, Government Code. The department may establish hydrogen refueling stations under provision of TC 227.

201.618 (f) requires that the department shall ensure that data on emissions from the vehicles and refueling stations purchased under this section and from the production of hydrogen for the vehicles and refueling stations are monitored, analyzed, and compared with data on emissions from control vehicles with internal combustion engines that operate on fuels other than hydrogen. The department has to report the results of the monitoring, analysis, and comparison to the Texas Commission on Environmental Quality.

201.618 (g) allows the department to cha*rge the public a reasonable fee to use a hydrogen refueling station* operated under Sub-section (b). The fee shall be based on the department's estimate of the number of customers who will utilize the refueling stations and the *direct and indirect costs* that will be incurred by the department to operate the refueling stations. Fees collected by the department under this section shall be deposited in the state highway fund, may only be appropriated to the department to implement this section, and are exempt from the application of Section 403.095, Government Code.

Comment: Given on this new vehicle technology insertion within legislation, there is a rationale for the department to request amendment to statute for the provision of plug-in-vehicle fuelling stations (given that this technology is moving forward and the fact that the TxDOT fleet may include plug-in-hybrids in the future, such as Nissan Leaf, Chevy Volt, Toyota Prius [whose plug-in-hybrid is scheduled for release in 2012], as well as for the department to charge the general public to use facilities.

<u>Control of Transportation Assets</u>

TC Chapter 202 lays out the control of transportation assets. Under TC Section 202.021 real property that is no longer needed –including ROW – can be transferred or sold if it was acquired for a highway purpose, and is determined it is no longer needed for a state highway. Real property can be transferred or sold to a governmental entity with condemnation powers, or to the general public (TC §202.021(b)). Highway ROW shall be transferred or sold given the following priorities: to a governmental entity with condemnation authority, to abutting or adjoining landowners, or to the general public. Section 202.024 provides for the exchange of real property that is not needed for highway purposes, as a whole or as a partial consideration for another interest in real property needed for a state highway purpose.

TC Sub-chapter C of Chapter 202 governs leases, easements, and agreements that concern highway property. Section 202.052 *allows the department to lease a highway asset, part of the ROW, or airspace above or underground a highway, if the department determines that the interest to be leased will not be needed for a highway purpose during the term of the lease*. The lease may be for any purpose that is *not inconsistent* with applicable highway use under sub-section 202.052 (b), and must charge *not less than fair market value* for the highway asset in cash, services, tangible or intangible property, or any combination thereof under Sub-section 202.052 (c). Exceptions for the charges under sub-section d can be made for lease to a public utility provider, leases for a social, environmental, or economic mitigation purpose, or for leases to an institution of higher education.

TC § 202.053 (a) provides that TxDOT may determine all terms of the lease except:

- the tenant may not be required to post a bond/security in excess of six months lease rental;

- the lease must allow the tenant to mortgage or other pledge or grant a security interest in the leasehold to secure financing for the acquisition of the leasehold, or construction or operations of an improvement that the lease allows (§202.053 (a) (1) and (2)).

TxDOT may not convey title to, or sever from the real property, any permanent improvement constructed on the area leased under this sub-chapter (§202.053 (b)).

Comment: Section 202.052 and 202.053 allow TxDOT to consider VEAs under these provisions. The determination will be whether the applications are "not inconsistent with applicable highway use," and how the department decides what is or isn't inconsistent and how TxDOT choses to implement the provisions. TxDOT may want to seek clarification from the Legislature, to ensure that such projects will not result in political opposition. This would also provide TxDOT with a better understanding of what type of applications the legislature supports. It would also provide guidance for how the Texas Administrative Code for transportation should be amended, and accordingly how TxDOT's in-house manuals should be amended.

TC §202.055 governs the lease of rest areas. The department can lease a rest area to a person engaging in sales, services, or other commercial activities that serve the travelling public.

TC § 202.056 prohibits the commission from entering into an oil and gas lease for real property owned by the state, that was acquired to construct or maintain a highway, road, street or alley.

Under TC § 202.058 the department may allow the owner of real property abutting or adjoining property acquired by the department for the ROW of a road in the state highway system, to use or cultivate a portion of the ROW not required for immediate use by the department. The agreement (in writing) may provide for:

1. use or cultivation of the property;
2. construction of improvements on the property;
3. placement of fences on the property; and
4. other matters.

Comment: This section gives TxDOT the authority to partner with adjacent property owners to implement some of the identified VEAs.

The department may not execute an agreement that would impair or relinquish the state's right to use the property for ROW when needed to construct or reconstruct the road for which it was acquired (§ 202.058 (d)). The use by the owner of adjoining or abutting property does not constitute abandonment of the property by the department.

Under Section 202.059 the department district engineer, on request, may, but is not required to, permit a person to mow, bale, shred, or hoe material on the ROW of a portion of a state highway that is in their district. If the person making this request is not the owner of the real property adjacent to the ROW that is the subject of the request, the district engineer must first provide the owner of the property the option of mowing, baling, shredding, or hoeing material on the ROW before granting permission to another person. A person permitted to mow, bale, shred, or hoe the ROW may not receive compensation for the mowing, baling, shredding, or hoeing, but is entitled to use or dispose of the hay or other material produced.

Section 202.060 allows the commission to adopt rules to implement a pilot project for leasing state highway ROW, subject to federal regulation of outdoor advertising, for *commercial advertising by means of a floral mosaic living logo* in a county with a population of over five hundred thousand.

Comment: Sections 202.059 and 202.060 provide the rationale for utilizing highway ROW for a value extraction purpose that use vegetation or other natural plant matter, including the mowing, baling, and movement of this type of vegetative component.

Section 202.061 allows the commission to enter into an environmental covenant for the purpose of subjecting real property—it has an ownership interest in for environmental remediation if this is approved by the Texas Commission on Environmental Quality, or a federal agency with authority to approve such.

Under Sub-chapter E Telecommunications Facilities, Section 202.092 telecommunication providers cannot place or maintain their facilities or otherwise use improvements, including structures, medians, conduits or lines, constructed or installed by the state as components of the highway system, except by lease under Section 202.052's provisions or an agreement under Section 202.093.

Section 202.093 allows the department to enter into an agreement with a telecommunications provider, to place their telecommunication facilities for a commercial purpose within the median of a divided state highway, or place lines within or otherwise use telecommunication facilities owned or installed by the state in or on the improved portion of the state highway, including a median, structures, equipment, conduits or any other component of the highway facility. The department can enter into an agreement that provides for cash compensation or the shared use of facilities. Section 202.094 requires that before the department enters into any such agreement that the department follow a procedure using competitive sealed proposals. Section 202.095 states that Government Code Title 10, Subtitle D State Purchase and General Services Chapter 2165 do not apply to telecommunication facility procurements under TC Subtitle A, Chapter 202, Sub-chapter E.

Comment: This is an area that can be pursued by TXDOT i.e., placement of telecommunication towers and equipment – to generate lease revenues.

Section 202.093(b) also notes that this sub-chapter does not limit a telecommunications provider from placing lines or facilities in the unimproved portion of state highway ROW to the extent authorized by applicable law.

Recommendation: Two main recommendations emerge from these provisions. First, once a planning process is established, TxDOT could review its property portfolio to assess how much real-estate it could theoretically utilize for implementing VEAs and their placement. Secondly, if real-estate is available in sufficient quantities, TXDOT could start to create a program in concert with multiple partners, such as utility partners, transmission line partners, renewable fuel production partners, for the use, or possibly exchange of property, even to the point of acquiring property held by transmission developers for highway development purposes. TXDOT could also utilize sub-section 202.052 (d)(1)'s exception clauses to justify such swaps

as part of a program to facilitate and enhance the state's RPS goals, and bring renewable energy or the sub-components to create biofuels, into the identified megapolitan growth areas of the state.

<u>Modernization of State Highways and Controlled Access Highways</u>

TC Chapter 203 sets out the department's role in facilitating the movement of traffic, *preserving the public's financial investment in highways,* promoting of public safety, and accomplishing the purposes of this chapter. Under Chapter 202.003 the commission may:

1. lay out, construct, maintain, and operate a modern state highway system, with emphasis on the construction of controlled access highways;
2. plan for future highways; and
3. convert, where necessary, an existing street, road, or highway into a controlled access highway in accordance with modern standards of speed and safety.

<u>Control of Access</u>

TC Chapter 203 Sub-chapter C – Control of Access sets out in Section 203.031(a) the duties of the commission who may:

(1) designate a state highway of the designated state highway system as a controlled access highway;

(2) deny access to or from a controlled access highway from or to adjoining public or private real property and from or to a public or private way intersecting the highway, except at specific locations designated by the commission;

(3) close a public or private way at or near its intersection with a controlled access highway;

(4) designate locations on a controlled access highway at which access to or from the highway is permitted and determine the type and extent of access permitted at each location; and

(5) erect protective devices to preserve the integrity, utility, and use of the controlled access highway.

Comment: When implementing any VEAs the department will also have to be cognizant of how these applications may impact access to and from a controlled access highway.

This is because the Commission under their authority to manage access to/from a controlled access highway under Sub-section 203.031 (a)(2) or (4), by rule – shall:

(1) require decisions by a department district denying a request for access to a specific location on a controlled access highway to be in writing and include the reasons for the denial;

(2) provide procedures for appealing a denial under Subdivision (1); and

(3) provide that properly platted access points to or from a controlled access highway that are located on undeveloped property are subject to the access management standards in effect at the time the points were platted regardless of when the initial request for access was submitted to the department, but only if:

a. development of the property begins and the request for access at the platted locations is submitted to the department before the fifth anniversary of the date the plat was recorded; and

b. the design of the highway facility in the vicinity of the platted access points did not materially change after the date the plat was recorded so as to significantly impact traffic patterns to the extent that the platted access points present a threat to public safety.

Section 203.031(4) requires that: (A) owners of land adjacent to a proposed highway construction project are given written notice at least 60 days before the date construction begins if the project will permanently alter permitted access to or from a controlled access highway at the owners' existing locations; and (B) the access described by Paragraph (A) be reinstated to the most practicable extent possible after due consideration of the impact on highway safety, mobility, and efficient operation of any changed traffic patterns resulting from the construction;

The Commission can adopt criteria for determining when a variance to access management standards may be granted, including criteria that, in addition to highway safety, mobility, and efficient operation, takes into consideration consequences resulting from denial of the owner's request for access to a specific location on a controlled access highway. For example, denial of reasonable access to the property, and undue hardship on a business located on the property.

Sub-Section 203.031 (6) allows the Commission to clarify that the remodeling or demolition and rebuilding of a business does not cause new access management standards to apply unless the department makes an affirmative finding in writing that the remodeled or rebuilt business will significantly impact traffic patterns to the extent that the current access location presents a threat to public safety.

Acquisition of Property

TC Chapter 203 provides the Commission with the following authority to acquire property (including through the use of eminent domain):

(1) an interest in real property;

(2) any property rights, including:
   - (A) a right of ingress or egress; and
   - (B) a reservation right in real property that restricts or prohibits for not more than seven years the:
     (i) addition of a new improvement on the real property;
     (ii) addition or modification of an existing improvement on the real property; or
     (iii) subdivision of the real property; and

(3) timber, earth, stone, gravel, or other material.

Property Code Chapter 21 applies to acquisition through eminent domain and the department's right to condemn the fee or a lesser interest in the property. Under condemnation the department shall, exclude from the interest to be condemned all the oil, gas, and sulphur that can be removed from beneath the real property. This exclusion shall be made without providing the owner of the oil, gas, or sulphur any right of ingress or egress to or from the surface of the land to explore, develop, drill, or mine the real property.

ROW Acquisition

TC Chapter 224 provides the mechanism through which the department can acquire ROW. The department can acquire by purchase, gift or eminent domain any ROW *necessary* for the national system of interstate and defense *highways* (§224.001). Section 224.001 also allows counties or municipalities to acquire, highway ROW requested by the department.

The Commissioners Court of any county may acquire by purchase or eminent domain any real property, including ROW, the commission determines *necessary* or *convenient* for a state highway to be constructed, reconstructed, maintained, *widened* or *extended* (Section 224.003(a)). In the acquisition of ROW by or for the TxDOT, the cost of relocating or adjusting utility facilities—which may be eligible under law – is considered a cost of the acquisition (Section 224.008).

The department is levied with the duty to develop and maintain the national system of interstate and defense highways and to provide for its *efficient maintenance, durability*, to perfect and extend a correlated system independent of state funds (Section 224.032).

Under Section 224.152 of the TC the department is authorized, subject to availability of federal and state funds, to *improve air quality and develop innovative techniques to finance transportation projects and enhance the use of existing highways and facilities* to further the purposes of the US Congress as expressed in 23 U.S.C. Sections 134 (metropolitan transportation planning), 135 (statewide planning), 146 (carpool and vanpool projects), and 149 (congestion mitigation and air quality improvement program). This directive could be interpreted to encourage State DOT participation in programs or initiatives such as providing ROW and/or property for renewable energy projects that would result in measurable improvements to air quality. The case would be more compelling if it was determined that a project could not move forward without DOT participation.

Comment: In TxDOT Project 0-6495 two recommendations were made "(i)[to] add in a policy preamble into transportation utility code that planning for a multi-modal system could assist the state in enhancing delivery of renewable capacity that would improve air quality. By facilitating and assisting in the development of transmission routes TxDOT could aid the state in developing its renewable energy capacity (which is extensive) to reduce reliability on fossil fuels, and (ii) the allocation of ROW for transmission could become part of the duty of the transportation commission and commissioner's courts as part of their planning processes (as recommended in the ***FHWA's 2009 memo also). This would allow TxDOT and local jurisdictions to develop a multi-modal infrastructure network to perfect and extend an integrated system of multimodal infrastructure networks." These recommendations could also apply to the implementation of projects such as the accommodation of solar panels in TxDOT ROW.***

Utility Relocation

According to TC § 203.092, TxDOT is also responsible for the cost of utility relocation, if the utility is required to move because of improvements to:

1. a highway that is part of the National System of Interstate and Defense Highways and where the relocation is eligible for federal participation;
2. any segment of the state highway system and the utility has a compensable property interest in the land occupied by the facility to be relocated; or
3. a segment of the state highway system that was designated by the commission as a turnpike project or toll project before September 1, 2005.
   - (a-1) Notwithstanding Sub-section (a)(3), the department and the utility shall share equally in the cost of relocating a utility facility that was implemented before September 1, 2013, and is required to relocate because of the addition of more tolled lanes to a nontolled highway. This sub-section expires September 1, 2013.
   - (a-2) Notwithstanding Sub-section (a)(3), TxDOT and the utility shall share equally in the cost of relocating a utility facility that is implemented before September 1, 2013, and is required to relocate because of the conversion of a nontolled highway to a turnpike project or toll project. This sub-section expires September 1, 2013.
   - (a-3) Notwithstanding Sub-section (a)(3), TxDOT and the utility shall share equally in the cost of relocating a utility facility that is implemented before September 1, 2013, and is required to relocate because of the construction of a turnpike project or toll project on a new location or the expansion of such a turnpike project or toll project. This sub-section expires September 1, 2013.

Section 203.092 (d) notes that the cost of relocation includes the entire amount paid by the utility properly attributable to the relocation less:

(1) any increase in the value of the new facility;

(2) the salvage value derived from the old facility; and

(3) any other deduction established by regulations for federal cost participation.

Comment: In considering utility VEAs, TxDOT should account for future costs if any utilities are required to relocate because the highway has to undergo improvements.

Purchasing ROW for Utilities & Transmission Line Development

TxDOT Project 0-6495 found that the only area in which TxDOT had been given authority to purchase ROW *specifically for utilities* is in the language that was inserted by HB 3588 in 2003. However, the 82nd Texas legislature in HB 1201 repealed the establishment and authority within Chapter 227 of Texas Transportation Code which allowed the purchase of ROW for utilities as part of the Trans Texas Corridor.

Natural Resources Code

Natural Resources Code Title 2 – Public Domain, Subtitle C – Administration, Chapter 31 – General Land Office, Sub-chapter E – Real Property Accounting and Management of the Natural Resources Code sets out the special status of certain agencies (TxDOT being one) regarding their real property portfolio.

Section 31.153 requires that all real property owned by the state shall be accounted for by the state agency that possesses it. Each agency shall maintain a record of each item of real property it possesses, and should include:

(1) a description of each item of real property by reference to a volume number and page or image number or numbers of the official public records of real property in a particular county, or if not applicable, by a legal description;

(2) the date of purchase of the real property, if applicable;

(3) the purchase price of the real property, if applicable;

(4) the name of the state agency holding title to the real property for the state;

(5) a description of the current uses of the real property and of the projected future uses of the real property; and

(6) a description of each building or other improvement located on the real property.

The General Land Office (GLO) Asset Management Division (Division) shall review and keep inventory records of all real property owned by the state and the Division shall compile the inventory records from information gathered under Sections 31.153 and 31.155 of the chapter (Section 31.154).

Under Section 31.155 the Division is not responsible for maintaining the inventory records of the real property administered by, among others, TXDOT. The agencies administering the real property shall maintain those records. However, TxDOT, at the request of Division, shall, submit its real property inventory records to the Division (Section 31.155 (b)).

The Division may review and verify the department's records and make recommendations regarding the department's real property. The commissioner shall prepare a report of the department's real property to the same extent that the Division and commissioner perform these functions for the records and real property of other state agencies (§31.155 (c)). Section 31.155 (e) notes that the duties of the Division to make recommendations regarding real property and of the commissioner to prepare a report involving real property do not apply to highway ROW owned by TxDOT.

Notwithstanding the special status of certain agencies under Section 31.155, Section 31.156 requires that the Division shall review the real property inventory of each state agency not less than every 4 years. The Division shall identify real property owned or controlled by the state that is not being used or is being substantially underused and make recommendations regarding the use of the real property or a real estate transaction involving the real property. As Section 31.155 *only exempts highway ROW owned* by TxDOT, under Section 31.156 *other types of real property owned by TxDOT* are subject to the review and recommendations of the Division.

Under Section 31.156 (c) the Division's recommendations <u>must</u> include an analysis of the *highest and best use* to which the real property may legally be placed and <u>shall</u> also include *alternative uses* of the real property addressing potential for commercial or agricultural lease of the real property or *any other real estate transaction or use* that the Division may deem to be in the *best interest* of the state. The section also requires submission of information pertinent to the evaluation of a real estate transaction involving the real property, including an evaluation of any proposals received from private parties that would be of significant benefit to the state and:

(1) if the Division recommends a real estate transaction, the market value of the real property and the current market conditions; or

(2) if the Division does not recommend a real estate transaction evidence of the real property's value in a form determined to be appropriate by the commissioner.

Section 31.157 requires an evaluation report to be drafted, which includes the results and findings from Section 31.156. The report is submitted to the Texas Building and Procurement Commission, which shall further evaluate the potential use of the real property by another state agency. A final report is to be submitted to the Governor, presiding officers of both houses of the legislature, the Legislative Budget Board and the Governor's budget office not later than September 1 of each year. However, the commissioner can submit a report at any time to the Governor under Section 31.1571 recommending real estate transactions or other actions involving real property included in the recent evaluation report that is not used or substantially underused. These are then submitted to the state agency and the Texas Department of Housing and Community Affairs who can file an objection. Real property that is reported as unused or substantially underused and recommended for a transaction may not be developed, sold or otherwise disposed of by the state agency before the earlier of the date the governor rejects a recommended real estate transaction involving the real property, or 2 years from the date the recommendation is approved (31.1571 (e)). If the state agency intends to dispose of or change the use of the real property prior to the time provided in Sub-section (e), the governor may require a general development plan for future use to be created.

Sections 31.1573 and 31.158 provide instructions for real estate transactions authorized by the Governor and the legislature, respectively. Monies accrued from these transactions are deposited into the Texas capital trust funds, unless proceeds are otherwise dedicated by the constitution to another fund, or the enabling legislation ordering the transaction provides otherwise. Sale or lease transactions are conducted through an open bid process under Section 31.158. Section 31.159 gives the School Land Board the first option to purchase real property authorized for sale. If the property being offered for sale or lease is for nongovernmental purposes and the property belongs to the state or a dedicated fund of the state the Division can promulgate a development plan for the real property (§31.161). Such a plan is subject to a public hearing (§31.1611) and must be submitted to the affected local government that may have jurisdiction over the real property (31.162). If rezoning is required, the Division can submit a rezoning request (§31.163).

Highway Beautification

Texas Transportation Code Title 6 Roadways, Subtitle H. Highway Beautification Chapters 391 through 430 govern the use of signs and outdoor advertising on and adjacent to the ROW.

Highway Beautification on Interstate and Primary Systems and Certain Roads

Section 391.001 TC sets out the definitions for this chapter and Section 391.002 describes the purpose of the chapter, which was to comply with – and is conditioned on– the Highway Beautification Act of 1965 (23 U.S.C. Sections 131, 136, 319) . Section (b) (1) notes the need to regulate the erection and maintenance of outdoor advertising, adjacent to the interstate and primary system to promote the health, safety, welfare, morals, convenience, and enjoyment of the traveling public as well as to protect the public investment in the interstate and primary systems. The following are listed as a means of protecting and providing for the general welfare of the traveling public and promoting the safety of citizens using the highways of this state:

1. landscaping and developing recreational areas;
2. acquiring interests in and improving strips of real property within, adjacent to, or within view of the interstate or primary system that are necessary for the restoration, preservation, and enhancement of scenic beauty; and
3. developing publicly owned and controlled rest and sanitary facilities in or adjacent to highway ROW.

Violation of the rule is subject to a misdemeanor punishable by a fine of not less than $500 or more than $1,000. Each day of a rule violation is regarded as a separate offense (§391.003).

Under Section 391.005 the chapter does not apply to a sign erected solely for and relating to a public election if the sign:

- is on private property;
- is erected not earlier than the 90th day before the date of the election and is removed not later than the 10th day after the election date; and
- is constructed of lightweight material and has a surface area not larger than 50 square feet.

The 82nd Legislature has also amended TC Chapter 391 by inserting a new section 391.006 that requires the Commission to establish by rule a complaints procedure for outdoor advertising complaints. Under a new section 319.0355 the Commission can impose an administrative penalty for violation of the chapter (in lieu of a suit to collect a civil penalty).

Sub-chapter B governs the regulation of outdoor advertising. Under Section 391.031 (a) an offense is committed if a person:

- erects or maintains outdoor advertising, or allows outdoor advertising to be erected or maintained on property owned by the person that is within 660 feet of the nearest edge of a ROW if the advertising is visible from the main-traveled way of the interstate or primary system; or
- outside an urban area if the advertising is located more than 660 feet from the nearest edge of a ROW, is visible from the main-traveled way of the interstate or primary system, and is erected for the purpose of having its message seen from the main-traveled way of the interstate or primary system.

Under sub-section 391.031 (b) no offense is committed if the person erects or maintains in an area described by sub-section (a) above:

1. directional or other official outdoor advertising authorized by law, including advertising pertaining to a natural wonder or a scenic or historic attraction;
2. outdoor advertising for the sale or lease of the property on which it is located;
3. outdoor advertising solely for activities conducted on the property on which it is located;

4. outdoor advertising located within 660 feet of the nearest edge of a ROW in an area in which the land use:
   A. is designated industrial or commercial under authority of law; or
   B. is not designated industrial or commercial under authority of law but the land use is consistent with an area designated industrial or commercial;
5. outdoor advertising that has as its purpose the protection of life and property; or
6. outdoor advertising erected on or before October 22, 1965, that the commission, with the approval of the secretary of the United States Department of Transportation, determines to be a landmark of such historic or artistic significance that preservation is consistent with the purposes of this sub-chapter.

Determining whether an area is to be designated industrial or commercial must be made using criteria established by Commission rule and according to actual land use. The offence under this section is a misdemeanor punishable by a fine of not less than $500 or more than $1,000 and again each day of the proscribed conduct is a separate offense.

Section 391.032 sets out the regulation of outdoor advertising in an industrial or commercial area. The commission, through rule, can regulate the orderly and effective display of outdoor advertising *consistent with the customary use* of outdoor advertising in this state in an area in which the land use:

- is designated industrial or commercial under authority of law; and
- is not so designated but in which the land use is consistent with areas designated industrial or commercial in the manner provided by Section 391.031(c).

Section 391.033 allows the Commission to purchase or acquire through eminent domain outdoor advertising that is lawfully in existence on a highway of the interstate or primary system.

Under Section 391.034 if the outdoor advertising that is erected or maintained endangers the health, safety, welfare, morals, convenience, and enjoyment of the traveling public and the protection of the public investment in the interstate and primary highway systems; and is a public nuisance the department shall order/require the removal of the advertising. If the owner does not acquiesce to remove it within 45 days of notice, the department can direct the Attorney General to apply for an injunction to:

- prohibit the owner from maintaining the advertising; and
- require the removal of the advertising.

Section 391.035 lays out the civil penalties for a person who intentionally violates this sub-chapter or Sub-chapter C.

The commission's responsibility for the regulation of outdoor advertising is only on a federal-aid primary highway, interstate highway, state highway, or farm-to-market road (Section 391.036).

Sub-chapter C sets out how the permitting and licensing of outdoor advertising will be controlled. Section 391.061 provides that willfully erecting or maintaining outdoor advertising in the area described by Section 391.031 (a) without license is a misdemeanor punishable by a fine not less than $500 or more than $1,000. Each day of the proscribed conduct is a separate offense.

Under Section 391.061 (c) a person is not required to obtain a license to erect or maintain outdoor advertising described by Section 391.031(b)(2) or (3).

License issuance and the period of licensing are governed under Section 391.062. The Commission issues licenses for 1 year or longer. Fees are set by the Commission. The surety bond required under Section 391.064 for an applicant of a license under Section 391.062 must be $2,500 for each county in the state where the person erects or maintains outdoor advertising; and is payable to the Commission for reimbursement for removal costs. The maximum in surety bonds that a person may be required to provide cannot exceed $10,000.

The 82nd Legislature also amended Chapter 391 TC by inserting within Section 391.063 a change to the amount of a license fee by a new metric of the number of off-premise signs under Chapter 394.

Section 391.065 allows the Commission to adopt rules to implement Sections 391.036, 391.061(a), 391.062, 391.063, 391.064, and 391.066 to efficiently manage the administration of this chapter, including the adoption of rules for issuing standardized forms. The Commission cannot adopt a rule that restricts competitive bidding or advertising by the holder of a license issued under this chapter other than a rule to prohibit false, misleading, or deceptive practices. Section 391.066 allows the commission to revoke or suspend a license, or place probation on a license holder. The 82nd Legislature added a new Section 391.0661 to RC regarding the applicability of license and additionally authorizes a person to erect or maintain an off-premise sign under Chapter 294.

Section 391.067 sets out the penalty for outdoor advertising – i.e., where a structure is willfully erected or the structure is maintained – without a permit. In this case the penalty is a fine of not less than $500 and not more than $1000 per day. Again, each day of the proscribed conduct constitutes a separate offence.

Section 391.068 governs the issuance of a permit. These are issued by the Transportation Commission. The Commission sets rules regarding reasonable fees and the application process. Under Section 391.068 (c) a permit issued by a political subdivision of the state regarding outdoor advertising can be submitted in lieu of the permit required in this sub-chapter as long as it complies with the sub-chapter and any rules adopted by the Commission. Under Sub-section (d) if the outdoor advertising is located in a municipality with a population of more than 1.9 million, that exercises its authority to regulate outdoor advertising, the commission may issue a permit under this section only if the municipality:

- has not acted to prohibit new outdoor advertising within the jurisdiction of the municipality; and
- has issued a permit authorizing the outdoor advertising.

Sub-section (d) does not apply to the relocation of outdoor advertising to another location if the construction, reconstruction, or expansion of a highway requires the removal of the outdoor advertising (§391.068(e)).

Section 391.070 reduces the permit fee to $10 for non-profit organizations for erecting and maintaining outdoor advertising in a municipality, or its extra territorial jurisdiction, when the advertising relates to, or promotes, only the municipality or political subdivision whose jurisdiction is wholly or partly concurrent with the municipality.

Sub-chapter D sets out the rules for specific information signs.

Comment: This VEA that generate revenues for TxDOT. Sub-chapter D thus provides a guide for how the department has created and implemented a specific use program adjacent to the ROW that could be coopted for future programs.

Section 391.091 provides that the department shall contract with an individual, firm, group, or association in Texas to erect and maintain specific information logo signs and major shopping area guide signs at appropriate locations along an eligible highway. Under this sub-section the contract can provide for remittance to the department at least 10 percent of the fees collected by the contractor. TxDOT is required to make the award to an offeror whose proposal offers best value for the state. In determining the best value for the state TxDOT may consider:

- revenue provided to the department by the contractor;
- fees to be charged eligible businesses or agricultural interests for inclusion on the signs;
- the quality of services offered;
- the contractor's financial resources and ability to perform; and
- any other factor the department considers relevant.

The Commission shall regulate content, composition, placement, erection and maintenance of specific information logo signs and supports on eligible ROW (§391.092). A specific information logo sign should look as shown in Figure I.2 (§391.092 (b) (1) and (2)):

A specific information logo sign may not contain a message, symbol, or trademark that resembles an official traffic-control device; or be divided into more than six panels that contain establishment names.

Figure I.2: Information Logo Sign

Under Section 391.092 (d) the commission will determine eligible highways along which specific information logo signs, major shopping area guide signs, and tourist-oriented directional signs may be located. If permitted by federal law, regulations, or guidelines, the commission may establish different highway eligibility criteria for each type of sign.

Eligibility for display on a sign is set out in Section 391.093. Commercial establishments – to be eligible to display their name on a specific information logo sign – must provide gas, food, lodging, camping, or pharmacy services and be located not more than 3 miles from an interchange on an eligible highway. If no service participating or willing to participate in the specific information logo sign program is located within 3 miles of an interchange, the Commission may grant permits to commercial establishments located 6, 9, and 12 miles from an interchange if the establishment (i.e., gas station, restaurant, lodging, or camp site) meets the criteria listed in Table I.5:

Table I.5: Information Logo Sign Establishment Criteria

	Gas station provides amenities such as vehicle services, tire repair, restrooms, drinking water, and a public restroom.
	Restaurant or establishment providing food, must have a required license, operate continuously for 10 hours a day and serve two meals and provide seating capacity for 16, restrooms, and a telephone.
	Lodging establishment provide at least 10 rooms and a telephone.
	Camping site must have required license and provide adequate parking accommodations; and provide drinking water and modern sanitary facilities.

Section 391.093 created the establishment of a program for erecting and maintaining major shopping area guide signs at appropriate locations along eligible highways. This is based on criteria that the Commission sets for determining geographic saturation of retail establishments that constitute a major shopping area, and are located not farther than 3 miles from an interchange on an eligible highway. Again the Commission can contract out the erection and maintenance of such signs and may collect a remittance of at least 10 percent of fees collected by the contractor. The signs can be included as part of exit direction signs, advance guide signs. However, the signs must include guide signs for both directions of traffic on an eligible highway.

Signs must be placed by the contractor (§391.095):

- at least 800 feet from the previous interchange and at least 800 feet from the exit direction sign at the interchange from which the services are available;
- two signs having the same legend are at least 800 feet apart, but are not excessively spaced; and
- a motorist, after following the sign, can conveniently reenter the highway and continue in the original direction of travel.

A specific information logo sign that is placed along a ramp or at a ramp terminal must be a duplicate of the corresponding establishment logo sign, except that the ramp sign must be smaller, include the distance to the commercial establishment, and include directional arrows instead of directions shown in words.

The Director of TxDOT can grant variances, on a case-by-case basis, regarding eligibility, location, or placement of specific logo signs and major shopping area guide signs, including the highways along which a sign may be located (§391.098). Variances may be granted if the director determines:

- the variance would promote traffic safety;

- the variance would improve traffic flow;
- an overpass, highway sign, or other highway structure unduly obstructs the visibility of an existing commercial sign; or
- the variance satisfies other conditions or guidelines prescribed by commission rules authorizing the granting of variances.

Section 391.099 lays out the rules for the tourist oriented directional sign program and again provides that the department can have a remittance of at least 10 percent of fees collected by the contractor.

Sub-chapter F sets the rules for real property acquisition for scenic enhancement. Under Section 391.151 the Commission may acquire, improve, and maintain a strip of real property adjacent to a federal-aid highway in this state if the property is necessary to restore, preserve, or enhance scenic beauty. The Commission can also acquire and provide rest and recreation areas or sanitary and other facilities in or adjacent to a highway ROW if the area or facility is necessary to accommodate the traveling public (§391.152).

Sub-chapter G allows the Commission to acquire any right or property interest that it considers necessary or convenient to implement this chapter (§391.181). Sub-chapter H governs regulation of outdoor advertising on SH 288. Sub-chapter I prohibits off-premise signs on certain listed highways (Sections391.252, 391.253, 391.254, 391.255).

<u>Signs on State Highway Right of Way</u>

Chapter 392 of Transportation Code sets out the rules regarding highway beautification on state highway ROW.

Sub-chapter A Landscape and Maintenance, Section 392.001 requires the department to plant and care for a substantial number of pecan trees on U.S. and state highways throughout the state. If the climate is unsuitable for pecan trees the department is required to plant other indigenous or adaptable trees that do not present a safety hazard. Section 392.002 requires the department to use xeriscape practices in construction and maintenance of roadside parks. Roadside parks include rest areas, picnic areas, a welcome station, or other facility that is provided for the convenience of the travelling public, and are within or adjacent to a highway, that is under the jurisdiction of the department.

Sub-chapter B sets out the rules for signs on state highway ROW and the definitions for this sub-chapter are found in Section 392.031. Section 392.032 covers the offense that is committed if a person places or maintains a sign on a state highway ROW not authorized by state law. The offence is a Class C misdemeanor.

Section 392.0325 sets out the exception to this chapter. A person may submit a request to the department for an exception to this sub-chapter for a sign that is attached to a building located on property other than a state highway ROW and that refers to a commercial activity or business located in the building if the sign (§392.0325 (a)):

(1) consists solely of the name of the establishment;

(2) identifies the establishment's principal product or services; or

(3) advertises the sale or lease of the property on which the sign is located.

The department shall approve a request submitted under Sub-section (a) if the department:

- determines that the sign will not constitute a safety hazard;
- determines that the sign will not interfere with the construction, reconstruction, operation, or maintenance of the highway facility; and
- obtains the approval of the Federal Highway Administration if approval is required under federal law.

This sub-chapter does not apply to a temporary directional sign or kiosk erected by a political subdivision as part of a program approved by the department and administered by the political subdivision on a highway within the boundaries of the political subdivision. It also does not apply to a sign placed in the ROW by a public utility or its contractor for purposes of the utility.

Section 392.033 allows the department – without prior notice – to remove a sign placed in violation of the chapter. Under section 392.034 the department can also remove a sign that is encroaching on state highway ROW and is not corrected within 31 days after receipt or a notice to the owner of the sign. Removal costs are liable by the owner to TxDOT for removal of signs (§392.035).

An individual who places or commissions the placement of a sign on state highway ROW (that is not otherwise authorized) is liable for a civil penalty of not less than $500 or more than $1,000 for each violation, depending on the seriousness of the violation and whether the person has previously violated this chapter. A separate penalty may be collected for each day a continuing violation occurs (§392.0355). The only defense to prosecution in a suit for violation under this chapter is if at the time of the alleged violation, the defendant was a candidate for elective public office and the sign is placed by a person other than the defendant and it relates to the public campaign for the elective office (§392.036).

Outdoor Signs on Public Rights of Way

Chapter 393 governs outdoor signs on the public ROW. A person may not place a sign on the ROW unless the placement is authorized by state law (§393.002). A sign may not be placed on right of way or a highway maintained by a municipality unless it is authorized by the municipality (§393.025). This section does not apply to ROW or a highway in the state highway system. The chapter lays out a few exceptions in Section 393.0026 for temporary directional signs or kiosks put up by a political subdivision as part of a program that is approved by the state, and administered by the political subdivision on the highway in its boundaries. The chapter also does not apply to a sign placed in the ROW by a public utility or its contractor for purposes of the utility.

The sheriff or constable authorized by the commissioner's court of the county can confiscate a sign placed in violation of Section 393.003. Section 393.004 states that the commissioner's court can exempt signs from the notice requirements of Section 393.003if they determine that the signs that are unlikely to be reclaimed if confiscated. In determining whether the signs are unlikely to be reclaimed, the commissioner's court may consider the value of the materials used in the signs and the nature/content of the advertisement.

Placement of unauthorized signs is a Class C misdemeanor (Section 393.005). The penalty for unauthorized placement is not less than $500 or more than $1,000 for each violation, depending on the seriousness of the violation and whether the person has previously violated this chapter. A separate penalty may be collected for each day a continuing violation occurs (§ 393.005).

Outdoor Signs on Rural Roads

Chapter 394 regulates outdoor signs on rural roads. The chapter only applies to a sign that is outdoors and visible from the main traveled way of a rural road (§394.002) that is located in an unincorporated area, that is not privately owned or controlled, of which any part is open to the public for vehicular traffic, and that is under the jurisdiction of the state or a political subdivision of the state. Section 394.003 sets out the exceptions (see Table I.6).

Table I.6: Exceptions

A sign that is allowed to be erected and maintained under the highway beautification provisions contained in Chapter 391;
A sign in existence before September 1, 1985;
A sign that has as its purpose the protection of life or property;
A directional or other official sign authorized by law, including a sign that pertains to a natural wonder or a scenic or historic attraction;
A sign that gives information about the location of an underground electric transmission line or a telegraph or telephone property or facility, a pipeline, a public sewer, or a waterline;
A sign erected by an agency or political subdivision of the state; or
A sign erected solely for and relating to a public election if the sign: • is on private property; • is erected not earlier than the 90th day before the date of the election and is removed not later than the 10th day after the election date; • is constructed of lightweight material; and • has a surface area not larger than 50 square feet.
(b) Sub-section (a)(2) does not exempt a sign from Section 394.048 to the extent that section applies. *(c) This chapter does not apply to a directional sign for a small business, as defined by Section 2006.011, Government Code, if the sign:* *(1) is on private property; and* *(2) has a surface area not larger than 50 square feet.* *(d) This chapter does not apply to a temporary directional sign or kiosk erected by a political subdivision as part of a program approved by the department and administered by the political subdivision on a highway within the boundaries of the political subdivision.*

The 82nd Legislature also amended TC Chapter 394, adding a new Section 394.006 that requires the Commission to set up a complaints procedure.

Sub-chapter B sets out the permitting process for an off-premise sign. Under Section 394.021 a person commits an offense if they erect an off-premise sign without a permit.

Except as otherwise authorized by this chapter, the commission may not issue a permit for an off-premise sign unless the sign is to be located:

- within 800 feet of a recognized commercial or industrial business activity or the office of a governmental entity; and
- on the same side of the road as the business activity or the office of the governmental entity.

If the off-premise sign is located within the jurisdiction of a municipality with a population of more than 1.9 million people that is exercising its authority to regulate off-premise signs, the commission may not issue a permit under this section if the municipality has acted to prohibit new off-premise signs within the jurisdiction of the municipality (§394.021 b-1).

Again under this sub-section an offense is committed if a person erects or allows a sign to be erected with knowledge that it is in violation of this chapter. The fine is regarded a misdemeanor and is not less than $500 or more than $1,000. Each day of the proscribed conduct is a separate offense.

The 82nd Legislature also added a new Sections 394.0201 through 394.0206 to Chapter 394 TC. Section 394.0201 relates to erecting an off-premise sign without a license, and sets out the offense under this section, as well as the fine which is not less than $500 or more than $1,000. Section 394.0202 also sets out the issuance and period of license under this section, and Section 394.0203 allows the Commission to set the fee according to a graduated scale by the number of off-premise signs, and units of outdoor advertising under Chapter 391 owned by a license applicant. The Commission can adopt rules to implement for the new Sections 394.0201 (a) through Section 394.0206. The rules must be for the efficient management (including a reduction in employees used to enforce the rules) and administration of the chapter. The Commission shall adopt rules for issuing standardized forms for permit requests that accurately show the number, location, or other information for each license holder's/applicant's off-premise signs or outdoor advertising under Chapter 391 (§394.0205 (b)).

The commission may not under Section 294.0206 (c) adopt any rules that restrict competitive bidding/advertising by the license holder. They can, however, create rules that prohibit false, misleading, or deceptive practices. The limitation provided by this Sub-section applies *only* to rules relating to the occupation of outdoor advertiser and does not affect the commission's power to regulate the orderly and effective display of an off-premise sign. A rule to prohibit false, misleading, or deceptive practices may not:

(1) restrict the use of:
 a. any legal medium for an advertisement;
 b. the license holder's advertisement under a trade name; or
 c. the license holder's personal appearance or voice in an advertisement, if the license holder is an individual; or

(2) relate to the size or duration of an advertisement by the license holder.

Permits shall be issued if the application applies with Commission rules and meets the requirements of this chapter (§394.022). If the sign is to be located within a municipality of more than 1.9 million that exercises its right to regulate off-premise signs, a permit from this jurisdiction must be obtained. Permits are valid for 1 year (§394.023). The Commission can require an applicant to file a surety bond or other security in a reasonable amount (§394.024). Fees are set by the commission and must recover the costs to enforce this chapter (§394.025). The commission can also revoke a permit if the holder violates this chapter (§394.026).

Sub-chapter C governs other general regulations, including height restrictions, face restrictions, wind loads, repair provisions, space between signs, computing face area of signs, and the number of signs. Height restrictions under Section 394.041 requirements are presented in Figure I.3:

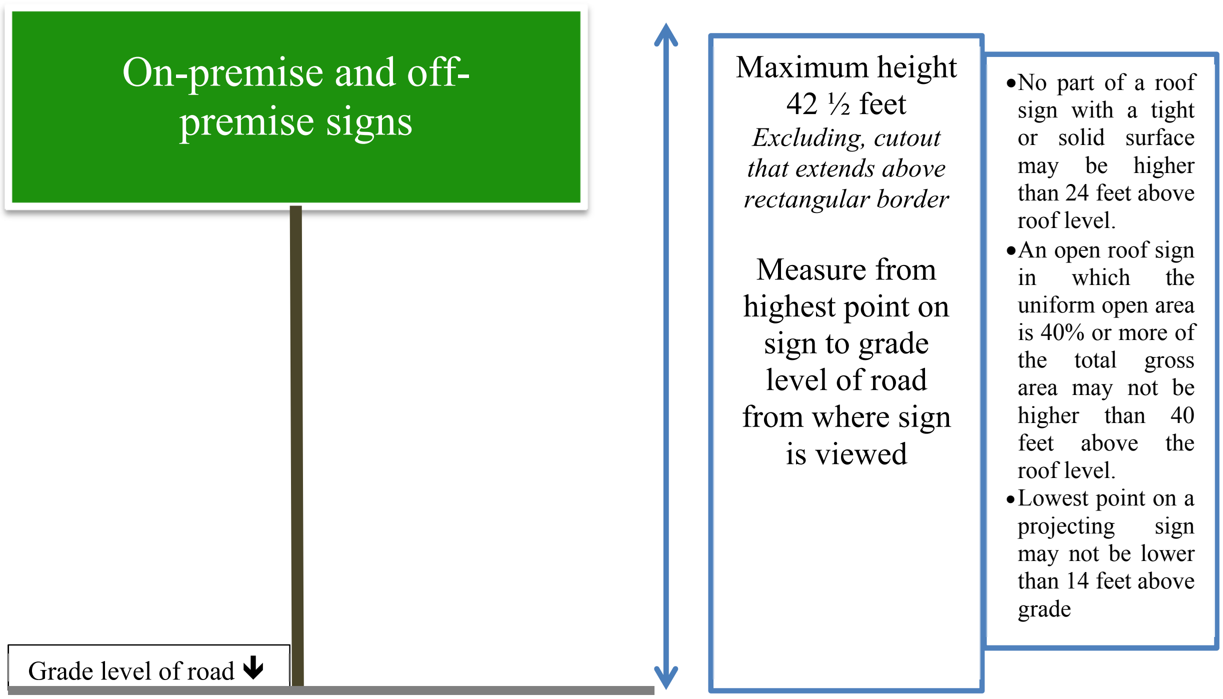


Figure I.3: On-premise and off-premise sign heights

Face restrictions under Section 394.042 require the Figure I.4 stipulations:

The cutout area of an off-premise or on-premise sign may not be larger than 20% of the sign's surface copy area. This section does not apply to: (1)a sign that advertises sale or lease of property on which the sign is located; or (2) an on-premise wall sign.

Figure I.4: On-premise and off-premise sign dimensions

Wind load pressure – Section 394.043 requires that on-premise and off-premise signs must be designed to withstand the wind loads shown in Table I.7.

Table I.7: Wind Load Pressure

Height in feet above ground	Wind load pressure in pounds (square foot)
0-5	0
6-30	20
31-50	25
51-99	35
100-199	45
200-299	50
300-399	55
400-500	60
501-800	70
Over 800	77
Height of a sign is measured above the average level of ground adjacent to the structure	

A sign or a substantial part of a sign that is blown down, destroyed, taken down, or removed for any purpose *other than for maintenance* or *for changing a letter, symbol*, or *other matter* on the sign may not be re-erected, reconstructed, or rebuilt unless the sign conforms with this chapter (§394.044). A sign or substantial part of a sign is considered destroyed *only* if the cost of repairing the sign is more than 50% of the cost of erecting a new sign of the same type at the same location.

Space between Signs – Section 394.045 requirements are proposed in Figure I.5.

Off-Premise
Face Area > 301 square feet

Not erected within 1500 feet of another off-premise sign on same side of road

Off-Premise
Face Area > 100 square feet and < 301 square feet

Not erected within 500 feet of another off-premise sign on same side of road

Off-premise
Face area < 100 square feet
Not erected within 150 feet of another off-premise sign on the same side of the road

A sign located at the same intersection where one or more other signs are located does not violate [the proximity to another sign] section if each of the signs is located so that the sign's message is directed toward the traffic flowing in a direction different from the traffic toward which any other sign's message is directed.

In this section, for purposes of measuring distance between signs, each double-faced, back-to-back, or V-type sign is a single sign.

Figure I.5: Space between signs

Section 394.046 sets out the computation of the face area of certain signs. Each face area of a double-faced, back-to-back, or V-type sign is considered a separate sign for the purpose of computing the face area under Sections 394.042 or 394.045. Under Section 394.047 a business may not maintain more than five on-premise signs for each frontage on a single road at a single business location.

Sub-chapter D governs the regulation of signs in populous counties. Section 394.061 finds that the commissioner's court may prohibit off-premise signs in the unincorporated area of a county with a population of more than 2.4 million people, or regulate location, size, height, and the anchoring of off-premise signs in the unincorporated area.

Section 394.063 governs on-premise signs in a populous county. The commissioners court of a county with a population of more than 2.4 million people or of a county that borders a county with that population may regulate, in the unincorporated area of the county, the location, size, height, and anchoring of on-premise signs.

Sub-chapter E sets out the enforcement program (civil and criminal). Section 394.081 holds that in lieu of being subject to a criminal penalty, a person who intentionally violates this chapter or a rule adopted by the commission under this chapter may be liable for a civil penalty of not less than $150 or more than $1,000 for each violation, depending on the seriousness of the violation and whether the person has previously violated this chapter. Each day a violation continues is a separate violation. Section 394.082 sets out the rules for civil enforcement of a violation under this chapter. Section 394.083 requires a court to order the revocation of a permit for which a violation of this chapter has occurred. Under Section 394.084 if a county has adopted a prohibition or regulation under Section 394.061, the attorney representing the county in district court may seek injunctive relief to prevent the violation or threatened violation of the prohibition or regulation. Section 394.085 governs violations of regulations or prohibitions adopted by populous counties regarding on-premise signs.

Section 394.086 sets out the rules for administering an administrative penalty for a violation of on-premise sign regulations in populous counties. The commissioners court of a county with a population of more than 2.4 million people or of a county that borders a county with that population may authorize a county employee to issue a civil citation to enforce a regulation of the commissioner's court adopted under Section 394.063. If a citation is issued, the commissioner's court may assess an administrative penalty not to exceed $100 for each day the violation exists. In determining the penalty amount, the commissioner's court shall consider the seriousness of the violation. Under Section 394.087 a sign that is erected in violation of this chapter is a public nuisance.

<u>County Regulation of Roadside Vendors and Solicitors</u>

TC Chapter 285 governs the regulation of roadside vendors or solicitors by counties with a population of more than 1.3 million people in the interest of public safety. The Commissioner's Court may regulate in the unincorporated area of the county, on a public highway or road, in the ROW or a parking lot:

(1) the sale of items by a vendor of food or merchandise, including live animals;

(2) the erection, maintenance, or placement of a structure by a vendor of food or merchandise, including live animals; and

(3) the solicitation of money (Section 285.001).

Under Section 285.002 the commissioner's court may:

- require a vendor or person soliciting money to obtain a permit to sell the food or merchandise or to solicit money;

- charge a reasonable fee for the permit; and
- provide for the removal of a structure that is in violation of the regulations.

If regulations adopted under this chapter conflict with a statute or state agency rule, the statute or rule will prevail *only to the extent of that conflict* (§285.003). An offense under this chapter is a Class C misdemeanor and each day constitutes a separate offense (§285.004).

Use of Municipal Streets and Sidewalks

TC Chapter 316 governs the use of municipal streets and sidewalks for public conveniences, amenities and private use. Permitted uses or improvements that the municipality can issue a permit for include:

- trees or decorative landscaping, including landscape lighting, watering systems, or other accessories for the maintenance of the trees or landscaping;
- a sidewalk cafe that is contiguous to a restaurant in which food preparation, sanitation, and related services for the cafe are performed and open to the air, except for a canopy, if not enclosed by fixed walls;
- an ornamental gate, column, or other ornamental work denoting the entrance to a neighborhood or platted and recorded subdivision;
- a supportive or decorative column, arch, or other structural or decorative feature of a building that is of historical value or of unusual architectural design, character, or significance, and 50 or more years old at the time of application for a permit for the establishment or maintenance of the feature; and
- an amenity for the convenience of the public in the use of the municipal streets for pedestrian or vehicular travel, including a transit bus shelter, drinking fountain, or bench.

The municipality can grant permission only to the person owning the underlying fee title to the real property, or an entity that holds the lease and has written permission to use the property from the fee title owner. Ornamental work may display the name of the neighborhood or subdivision, but may not contain commercial advertising or other signs (Section 316.002).

The municipality in issuing the permit must make a finding that the improvement or facility will not be located, extend onto or intrude into the roadway, or (part of) the sidewalk used for pedestrian use (§316.002 (b) (1) and (2)).

Under Section 316.003 the municipality can establish by ordinance a permit program to implement the provisions of this sub-chapter. The ordinance shall include:

1. any provisions at the site of an applicant's proposed facility determined necessary or desirable to protect, the public, utility companies, and any person who has the right to use the municipal street;
2. provisions that require:
   - The clearances between the facility or improvement and utility lines that comply with the clearances between structures and utility lines required by a nationally recognized building code;

- The permit holder to provide a cash/surety bond sufficient to cover the costs for the municipality or a public utility to remove the permit holder's facilities or improvements; and
- a permit holder to pay for the relocating a municipal or public utility facility or improvement in a municipal street because of the installation of a facility or improvement by the permit holder; and

3. provisions authorizing the municipality or a utility company to remove, without liability, any part of a facility for which a permit has been issued if there is a lawful need for the site or for access to the site.

The governing body may include in the ordinance:

1. construction, maintenance, operation, and inspection requirements;
2. public liability insurance requirements;
3. requirement that the applicant or permit holder pay for traffic and safety studies;
4. provisions for conducting a public hearing on the issuance, renewal, or revocation of a permit, with notice and reporting expenses of the hearing to be paid by the applicant or permit holder;
5. requirement for indemnity agreements by abutting fee title land owners in the form of covenants that run with the title to the abutting land; or
6. provisions that authorize the governing body, at its discretion, to terminate the permit without notice to the permit holder.

Under Section 316.007 a municipality may establish or maintain – with municipal money, material, equipment, or personnel – an improvement or facility described by Section 316.002(a)(1) or (5) without a permit, regardless of whether the municipality establishes a permit program under this chapter. A municipality must make the finding required by Section 316.003 regarding an improvement or facility the municipality proposes to place on a municipal street.

Texas Administrative Code Review

Title 43 Transportation Chapter 21 Right of Way

Sub-chapter J: Leasing of Highway Assets for Transportation Facility

Rule 21.301 establishes the procedure for *leasing state-owned ROW* for *freight movement* to reduce congestion on the state highway system and to improve air quality when the commission authorizes such a lease for a specified project. Under Rule 21.301 (b) this sub-chapter *may not* be used for the lease of ROW for of a pipeline, electric transmission line, or other utility facility. Additionally, this sub-chapter may not be used for the lease of ROW for rail lines that are part of the general system of rail transportation and require a certificate from the United States Surface Transportation Board under 49 U.S.C. §10901. The procedure provided by this sub-chapter is separate from and in addition to the procedure established under Sub-chapter L of this chapter that relates to the Leasing of Highway Assets.

Under Rule 21.303 the department can issue a request for proposal (RFP) from public and private entities for submitting a detailed document describing a proposed project and the associated lease of ROW. The RFP will provide the information necessary for a responsive proposal.

The RFP will set out in detail the specific evaluation criteria that the department establishes for the project under Rule 21.305 of this sub-chapter (relating to Selection of Entity) Rule 21.303 (c). A RFP may describe the geographic limits of potential ROW to be leased. The department *will* publish notice of the intent to issue the RFP on the department's Internet website, Texas Register, and at least one newspaper of general circulation in the state. The department may also furnish notice to entities associated with freight movement that the department believes might be interested and qualified to participate in submitting a proposal. Rule 21.303 (g) notes that the department cannot accept unsolicited proposals.

Rule 21.304 sets out the criteria for a proposal to be considered responsive. Rule 31.305 provides how the department will evaluate the RFP based on the criteria it considers appropriate for the project. These may include comparative value of estimated emissions reductions generated by the proposed transportation facility, the revenue potential to the state, the current viability of proposed technology, the financial viability of the proposer, or other factors that the department reasonably determines are relevant to the project. The department can select one or more entities that offer best value to the department or can reject all proposals. The department will then submit a recommendation to the commission regarding the approval of proposals determined to provide apparent best value. The Commission can disapprove/approve the recommendation if it finds that:

1. one or more alternative freight transportation facilities are available that result in lower emissions than the emissions produced for the movement of the same amount of freight an equivalent distance by truck;
2. part of the ROW of, the airspace above, or the underground space below a highway that is part of the state highway system will not be needed for a highway purpose during the term of the lease and is suitable for the identified mode of moving freight;
3. the use of the ROW, airspace, or underground space for the identified mode of moving freight would not be inconsistent with applicable highway use; and
4. the lease of the property described in paragraph (2) of this sub-section would be economically beneficial to the department, c the receipt of lease payments and the reduced maintenance costs on the state highway system.

The execution of such an agreement is subject not only successful negotiation, but also any necessary federal action and satisfaction of other conditions identified in the RFP or by the Commission. Rule 21.306 lays out how negotiations will take place, including how the department may negotiate with the next highly ranked proposal if the negotiation with the approved proposer falls through.

Rule 21.307 defines the terms for the agreement that is negotiated under this sub-chapter. The agreement is subject to FHWA approval. The department may also not execute an agreement that would impair or relinquish the state's right to use property for a ROW purpose, if needed to construct or improve the roadway for which it was acquired. If the project does not obtain the required governmental approvals the department will cancel the lease. The agreement must contain:

1) the lease term amount of rent and required deposits, if any, and method of payment;
2) a detailed description of the ROW to be leased, including a three-dimensional description if needed;
3) a general design for the use of the leased ROW, including any improvements to be constructed, all maps, plans, or sketches necessary to set out the pertinent features in relation to any highway facility, and a description of any temporary improvements to be provided by the lessee;
4) performance bond and payment bond, as provided for under TC §202.053;
5) removal bond in an amount equal to the anticipated future cost of removing any improvements, as well as the restoration and mitigation of the ROW to a suitable and safe condition, based on a removal, restoration, and mitigation plan approved by the department;
6) appropriate terms relating to indemnity, liability, insurance, and risk of loss; and
7) any other provisions considered necessary or desirable by the department.

The agreement must provide that the selected proposer is responsible for:

1. The preparation of any environmental review documents required under federal law or Chapter 2 of this title (relating to Environmental Policy);
2. The preparation of applications and obtaining any environmental permits or other approvals by third parties or governmental entities;
3. The funding of all planning, design, testing, construction, operation, or maintenance of the lessee's proposed activities, with acknowledgement of the lessee's right to mortgage or otherwise pledge or grant a security interest in the leasehold to secure financing for the acquisition of the leasehold and for the construction and operation of an improvement permitted under the lease;
4. making any changes to existing highway facilities at its sole expense for the proper operation and maintenance of the facilities if the department determines that the proposed use of the leased ROW requires changes or additions;
5. acquiring additional real property rights located outside of the department's holdings that are necessary to conduct the proposed activities; and
6. all utility adjustments and relocations required for its proposed activities.

Rule 21.308 covers the termination of the agreement. Rule 21.309 covers payment that can be charged by TxDOT for the ROW. This cannot be less than fair market value unless the Commission authorizes an exception. The department is required to consider its costs in administering the agreement when establishing the lease amount. Deposits will be placed into Fund 6. Rule 21.310 requires that subleases *must* be approved by the department. If the sub-lessee is a utility provider, the installation, adjustment, relocation, and maintenance of its facilities must be in accordance with the department’s utility accommodation policy.

Under Rule 21.311 the department cannot convey title to, or sever from the real property, a permanent improvement constructed on the property leased under this chapter. Outdoor advertising is not permitted under an agreement under this sub-chapter. Any common carrier responsibilities are the responsibility of the proposer. Use of ROW under an agreement of this sub-chapter does not constitute abandonment of the property by the department.

Sub-chapter K: Control of Signs Along Rural Roads

Rule 21.401 regulates the orderly and effective display of outdoor advertising on rural highways and roads located outside of corporate limits of towns, cities, and villages.

Signs that are prohibited under Rule 21.403 include:

a. A sign may not be erected or maintained on a tree or painted or drawn on a rock or other natural feature.

b. A sign may not be erected or maintained within the right of way of a public roadway or an area that would be within the right of way if the right of way boundary lines were projected across an area of railroad right of way, utility right of way, or road right of way that is not owned by the state or a political subdivision.

c. A sign may not be erected or maintained on a highway or part of a highway designated under Transportation Code, §391.252.

d. A sign may not be erected or contain a display that imitates or resembles any official traffic sign, signal, or device.

Under Rule 21.404 an off-premise sign cannot be erected without a permit. Rule 21.405 lays out the exemptions for this sub-chapter that include:

(1) signs allowed under the highway beautification provisions of the Transportation Code, Chapter 391;

(2) signs in existence before September 1, 1985, that was properly registered and maintains a valid registration under §21.407 of this subchapter (relating to Existing Off-Premise Signs);

(3) signs for the purpose of the protection of life and property;

(4) directional or other official signs – authorized by law – including signs for natural or scenic wonders or historic attraction;

(5) signs or marker giving information about the location of an underground electric transmission line, telegraph or telephone property or facility, pipeline, public sewer, or waterline;

(6) a sign erected by a governmental entity;

(7) a sign erected solely for and relating to a public election, but only if:
   a. the sign is on private property;
   b. the sign is erected after the 91st day before the election and is removed before the 11th day after the election;
   c. the sign is constructed of lightweight material;
   d. the surface area of the sign is not larger than 50 square feet; and
   e. the sign is not visible from the main-traveled way of an interstate or federal-aid primary highway;

(8) off-premise directional signs for a small business, as defined by Government Code, §2006.001, that is on private property and is no larger than 50 square feet;

(9) signs required by the Railroad Commission of Texas at the principal entrance to or on each oil or gas producing property, well, tank, or measuring facility to identify or to locate the property, that is no larger in size than is necessary to comply with the Railroad Commission's regulations, and that has no advertising or information content other than the name or logo of the company and the necessary directions;

(10) signs that shows only the name of a ranch on which livestock are raised or a farm on which crops are grown and the directions to, telephone number, or internet address of the ranch or farm and that has a sign face that does not exceed an area of 32 square feet; and

(11) signs identifying the name of a recorded subdivision located at an entrance to the subdivision or on property owned by or assigned to the subdivision, home owners association, or other entity associated with the subdivision.

Rule 21.406 notes that this sub-chapter does not apply to off-premise signs in unincorporated areas of counties with a population of 2.4 million people (or more), if the county either prohibits or regulates the location, size, height, anchoring, or other such use of a portable sign.

Existing signs, i.e., those that were registered not later than December 30, 1985 and existed before September 1, 1985, are valid as long as the registration remains valid. The registration only remains valid for the location indicated on the original registration. The registration also allows for routine and customary repairs (Rule 21.407). Rule 21.408 governs the continuance of nonconforming sign permits if it the sign was lawful on the date it was erected or became subject to TxDOT control.

Rule 21.409 sets out the permit application process. Rule 21.429 sets out the spacing of signs. Off-premise sign that have a sign face area of at least 301 square feet and not be located within 1,500 feet of another off-premise sign on the same side of the roadway. For off-premise signs with a sign face area of between 100-301 feet must not be located within 500 feet of another off-premise sign that has a sign face range or within 1500 feet of an off-premise sign face of at least 301 square feet on the same side of the roadways. Signs may not be located in places that create a safety hazard (21.429 (j), must be within 800 feet or a recognized commercial/industrial activity, and not located within 1,000 feet of a rest area.

Rules 21.431, 21.432, 21.433 set out wind load pressure, height restrictions and lighting respectively. Repair and maintenance of the signs is set out in Rule 21.434. The next four rules set out guidelines for relocation of signs (Rules 21.435 through 21.438). Rule 21.439 sets out the guidance for discontinuance of a sign due to destruction.

The department under Rule 21.440 can order removal of a sign if the permit expires or is cancelled, or if the sign is erected in maintained in violation of the rules of this Subchapter K.

Rule 21.442 sets out the guidelines for On-Premise signs, which are permitted under this section. Business may not maintain more than five on-premise signs on a frontage road of a single rural road at a single business location.

Sub-chapter L: Leasing of Highway Assets

Rule 21.602 notes that the commission can authorize the lease of a highway asset if it finds:

1. the interest to be leased will not be needed for highway purposes during the period of the lease;

2. the lessee's use of the property will be consistent (and not impede) with safety, maintenance, operation, and the beautification of the state highway system; and
3. the lease will be economically beneficial to the department.

The director can authorize the lease given the above findings and if the lease does not exceed 2 years, or contains a cancellation clause so the department, at its sole discretion, can terminate the lease with no more than 2 years notice. Leases will be awarded on a sealed bid basis and the department will not charge less than fair market value for leases (Rule 21.603).

Rule 21.604 requires that the lease shall be in written form, and include:

- contact information,
- a detailed description of the asset to be leased, including a three-dimensional description of where vertical limits are needed,
- a general design of the asset, including any improvements to be constructed and maps, plans, sketches *necessary* to show pertinent features in relation to highway facilities,
- a description of any temporary improvements to be provided by lessee,
- a general description of the leased asset, including any improvements,
- the rental amount, including deposits and the term of lease and payment,
- a statement on the authorized use of the leased asset and the requirement that any change of use requires prior written approval of the director of the department,
- a requirement for department approval of all construction plans regarding the asset,
- permission for employees of the department to enter the property for inspection, maintenance, reconstruction of highway facilities as necessary, or to determine lease compliance,
- that any improvements will be maintained by lessee at their expense, and must be kept in good condition for safety and appearance and not interfere with highway use,
- that if the district engineer determines that the lessee has failed in maintenance obligations, the department has the right to enter and perform this work at the expense and liability of lessee,
- a statement requiring forfeiture of the deposit, payment of litigation costs or other expenses due to nonperformance of the lease terms,
- a performance bond,
- adequate public liability insurance for the leased asset, conduct of lessee’s business, and their indemnifications and obligations to the department, to be paid for by lessee and naming the department as an additional insured, and include other endorsements acceptable to the department for damages occurring to the highway facility, or for public or personal injury, loss of life, or property damage. The director can waive this requirement where the lease is with a county, city, state

agency or federal government if they assume specific responsibility for such payments,

- that the lease can be terminated, if the district engineer determines that the asset has:
    - ceased to be used in accordance with agreement provisions,
    - is abandoned, or in the case of
    - noncompliance with the terms of the lease or conditions are violated and not corrected,
- that the lease cannot be conveyed or transferred to another party without TxDOT approval,
- that the lease or any improvements are kept free of any liens and not used as security for a loan, provided that the lessee is allowed to mortgage or pledge or grant a security interest to secure financing for the acquisition of the leasehold and construction/operations of the approved improvement,
- that the lessee assumes all risk of losses resulting from the lease, and
- any other provisions deemed necessary or desirable by the director

Rule 21.605 sets out the general requirements relating to the leasing of federal-aid ROW. The use of leased ROW beneath the established gradeline of the highway shall provide sufficient vertical and horizontal clearances for the construction, operation, maintenance, ventilation, and safety of highway facilities (Rule 21.605 (b)). The use of leased highway ROW above the established gradeline of the highway shall provide for vertical and horizontal clearances (Rule 21.605(c)). Piers, columns, or any other portion of any improvements to be constructed on the leased ROW cannot be erected in a location that will interfere with visibility (or reduce the sight distance) *or in any other way i*nterfere with the safety and free flow of traffic or level of service on highway facilities. Structural supports for any improvements must be located clear of all horizontal/vertical dimensions specified by the department (Rule 21.605 (e)). All these restrictions and the use of the ROW shall not result in highway and non-highway users being unduly exposed to hazardous conditions (Rule 21.605 (f)). This includes a requirement in Rule 21.605 (g) for appropriate safety precautions and features *necessary* to minimize the possibility of injury to users of the highway or the leased facility be provided. The department will determine the acceptability of these features considering the adequacy for evacuation of structures in case of a major accident.

All improvements constructed on the leased asset must be fire resistant and adhere to local applicable building codes. The use of the asset cannot be a hazard to highway or non-highway users. If the department questions the acceptability of the existing local applicable building codes, conformance with a nationally accepted model building code, or any other code acceptable to the department may be required.

Structures built over the ROW shall occupy no more length of highway than authorized by the department (Rule21.605 (i)). Rule 21.605 (j) requires that the design and occupancy of such a structure over or under the ROW shall not affect safety, appearance, or enjoyment of the highway through the spillage of fumes, vapors, odors, droppings, or discharge from the structure. Signs and displays developed or maintained by the lessee are restricted to those indicating ownership or on-premise activities and must be authorized by the department subject to the Highway Beautification Act.

Construction of any structure above or below a highway shall not require any temporary or permanent change in alignment or profile of an existing highway without prior written approval by the department. If the use requires changes to or additions to the existing highway facility, these shall be provided without cost to the department (Rule 21.605 (l and m)). Improvements on the leased ROW shall be designed and constructed to permit access to highway facilities for maintenance, inspection, and reconstruction when necessary (Rule 21.605 (n)). Lessees wanting to lease highway assets are required to furnish at their expense, all engineering, appraisal and other reports, designs, and findings to the department (Rule 21.605 (p)).

Rule 21.606 sets out the requirements for requests to lease a highway asset. All lease requests must be in written form and require the following details:

- the proposed lessee,
- description of area or interest to be leased, proposed term of lease, improvements (if any are proposed for construction) and the intended use of this leased asset,
- sketches and/or drawings of the area to be leased, any proposed improvements including utilizing, existing highways or other improvements, proposed access and drainage plans,
- any information that supports the findings to authorize the lease,
- other additional information that the District Engineer may request.

This will be forwarded to TxDOT's ROW division for processing, to prepare – when appropriate –a recommendation for the Commission to submit to the FHWA.

Title 43 Transportation Chapter 22 Use of State Property

<u>Sub-chapter B: Use of State Highway Right of Way</u>

Rule 22.10 sets out the department's policy to use ROW for certain public purposes, which benefit the general public and are consistent with the efficient and safe operation of the state highway system. This chapter prescribes policies and procedures governing the use of state highway ROW other than department business. Rule 22.14 sets out the policy vis-à-vis vendors using the state highway ROW.

Rule 22.14(a) states that encroachment on highways and ROW of the state highway system by unauthorized structures and vehicles and by roadside vendors causes damage to the system, increases litter, and frequently creates unsafe or hazardous conditions.

Policy is set out in Rule 22.14 (b) and stipulates that:

1. A person may not park or place any vehicle or structure, wholly or partly within the ROW of a state highway, for the purpose of selling the same or of selling any article, service, or thing from such vehicle or structure, except as provided in paragraph (2) of this sub-section.
2. The prohibition described in paragraph (1) of this sub-section does not apply to:
   a) placing, constructing, or maintaining a structure pursuant to other statutory authority;

b) an activity undertaken pursuant to the terms of a ROW lease entered into under the provisions of Texas Civil Statutes, Article 6673a-3;

c) the sale of an edible agricultural commodity for a period not to exceed 60 days, within the ROW of a state highway other than a controlled access facility, if that commodity was grown or produced upon the property immediately abutting the affected ROW; or

d) any other activity expressly authorized by law.

A person who desires to engage in an activity, as identified in sub-section (b)(2)(C) of this section, must file an at the department's district office not fewer than 7 calendar days prior to the requested date of placement. The application shall be in a form prescribed by the department and shall at a minimum require:

- contact details, a tax statement or proof of ownership, or written permission from owner,
- proposed location of the vehicle or structure (distance from the roadway) and the size of the encroachment (height, width, and length),
- the proposed time period of the encroachment,
- the commodities being sold, and
- any other terms and conditions that the department may require.

Restrictions

The location approved under Rule 22.14 (e) shall be as far from the edge of the pavement as possible, and may not be in a place:

A. where the encroachment may cause sight restriction or a safety problem;

B. inside the clear zone as defined in the latest edition of the Department's Design Division Operations and Procedure Manual;

C. which will conflict with scheduled maintenance or construction actions;

D. which will cause substantial negative impacts to the environment, including landscape features; or

E. where customers could park their vehicles in such a way as to create a safety hazard.

A person authorized to utilize ROW under this section may not place a sign on the ROW, vehicle, or the structure.

The district engineer reviews the application and approves the location if the use of the ROW complies with this section, subject to any additional terms and conditions deemed necessary to protect the safety of the traveling public. A written agreement must be entered into with the department (Rule 22.14 (f)). The terms and conditions that must be included to protect the public safety include, but are not limited to:

Table I.8: Terms and conditions to protect public safety

the physical description of the encroachment;
the approved location of the encroachment;
the approved time period of the encroachment;
the commodities being sold;
statement that the requestor will avoid or minimize impacts, and will, at its own expense, restore or repair damage occurring outside the ROW and restore or repair the ROW, including roadway and drainage structures, signs, pavement, etc., to a condition equal to that existing before the encroachment, and, to the extent practicable, restore the natural environment, including landscape features;
statement that the requestor is responsible for any damages or accidents, which may occur during the time period of the encroachment and to save the state harmless;
statement that the requestor will abide by all applicable federal, state, and local environmental laws, regulations, ordinances, and any conditions or restrictions required by the department to protect the natural and cultural resources of the ROW; and
statement that if hazardous traffic conditions developed due to the presence of the encroachment, the requestor shall correct the measure as the department requires.

Rule 22.16 implements TC Section 392.0325, which authorizes a person to submit to the department a request to maintain certain signs that encroach on state highway ROW. This section prescribes policies and procedures by which a person may obtain approval.

A request for approval under this section must be submitted to the appropriate department district office. The request shall be on a form prescribed by TxDOT and shall at a minimum include:

- contact details;
- proposed location (including, distance from the pavement and mounting height);
- proposed text, background color, and legend color for the sign;
- size and composition of the sign (including, height, width, thickness, and sign material);
- proposed method of support for the sign (dimension and material);
- detailed plans for the installation and maintenance of the sign;
- traffic control plan that incorporates requirements contained in the Texas Manual on Uniform Traffic Control Devices;
- if it will be necessary to use state highway ROW to install or maintain the sign; and
- if applicable, a brief statement about the historic significance of the sign and of the building to which the sign is attached.

The district may require additional information determined necessary to properly evaluate the request. All costs necessary to collect information required under this sub-section are the sole responsibility of the requestor. Approval is subject to the aforementioned provisions. The director will approve the request if he determines that the sign will not constitute a safety hazard and not interfere with the construction, reconstruction, operation, or maintenance of the highway facility. In addition, FHWA approval needs to be obtained if federally required. The director will not approve a request if:

- the sign is attached in any manner to a structure on the ROW,
- the sign encroaches into the clear zone as defined by the Texas Manual on Uniform Traffic Control Devices;
- the sign encroaches on ROW that is scheduled for future construction or rehabilitation in the department's Unified Transportation Program;
- the sign has utilities located above or below the proposed sign;
- the sign will distract from direction or other official signs authorized by law; or
- the sign will unduly distract the traveling public.

The director will take into account the historic significance of a building, the attached sign and if the sign is a contributing feature of the building. If the director approves a request an agreement will be entered into with the department. If the requestor is not the owner of the building to which the sign will be attached, the building owner must also be a party to the agreement. The agreement will include:

1. any additional terms and conditions deemed necessary to protect the safety of the traveling public;
2. a statement that the requestor and owner shall indemnify and save harmless the state, its officers, employees, agents, and contractors from claims arising from or connected with the requestor's use of the ROW under the agreement; and
3. a statement that the requestor and owner shall be responsible for the removal or relocation of the sign, necessitated by to improvements to the highway facility.

The remaining three sections cover violation, denial of a request, and the appeal process.

Bills Before 82nd Texas Legislature

Bills that came before the 82nd Texas Legislature that had the potential to impact the use and management of ROW and other real estate assets are described below (as of July 62011).

Table I.9: Bills Before the 82 Texas Legislature

Bill No	Description	Companion Bills	Status
HB 1360	Amends local government code to authorize commissioner's court to prohibit off-premise signs along roads in the unincorporated area, but would not require removal of existing signs before the effective date of the bill. Prior to issuance of an order the commissioners court would be required to hold a public hearing and publish a notice in a newspaper	SB 1354	Left pending in committee March 24, 2011
HB 1729	Relates to sale of surplus leased land by a government entity to a private party at fair market value. Bill authorizes entity to pursue a sale of land to a bulk purchaser, instead of lessee through passage of resolution.	SB 1570	Placed on General State Calendar May 12, 2011
HB 1768	Amends transportation code authorizing county commissioner court to regulate roadside vendors and solicitors in the unincorporated area of the county under certain circumstances. Lowers minimum county population threshold from 1.3 million to 450,000 to which it applies.. Prohibits such an order from prohibiting sale of livestock.	None	Vetoed by the Governor
HB 2259	Amends natural resources code regarding the drilling permit road fee for county repair and maintenance of public roads.	None	Left pending in committee March 24, 2011
HB 2289	Relates to the authority of a gas corporation to use public ROW along a railroad, railroad ROW, or interurban railroad and , street railroad. Amends prior legislation that was intended to encourage construction of pipelines in public ROW rather than private property, gave gas corporations authority to lay a pipeline over, under, along or across a public road, railroad ROW, interurban railroad, street, canal or stream. Authorization is removed to lay and maintain a pipeline along a railroad or a railroad ROW.	None	Signed by Governor June 17, 2011 – effective immediately
HB 2969	Requires General Land Office to offer for sale real tracts of property delineated in the bill. This includes TxDOT's Bull Creek Property at Camp Hubbard. Prohibits sale of this property until TxDOT relocates its operations to another location. All sale proceeds will be deposited to the general revenue fund.	None	Reported out engrossed, received from House in Senate May 5, 2011, referred to Natural Resources May 9, 2011
HB 3044	Amends Section 285.001 of transportation code regarding regulation of roadside vendor and solicitor activities. Deletes provision of applying only to a county with a population of more than 1.3 million people. Adds the regulation of sale of live dogs and cats.	None	Withdrawn from schedule April 14 2011
SB 1420	Sunset bill for TxDOT – includes changes to outdoor advertising, including the requirement for the Commission to establish by rule procedures for accepting and resolving complaints.		Signed by Governor – effective September 1, 2011
SB 1513	Amends Sub-chapter Z, chapter 216 by adding 216.904 to local government code regarding regulation of off-premise signs. Restrict to county with population of more than two million people that is adjacent to a county with a population of more than one million people. A municipal ordinance or statute regulating off-premise signs may not require relocation, reconstruction or removal of a sign that is located in an area of municipality that was annexed after sign was originally constructed, and adjacent to a highway or proposed highway		Referred to Senate transportation & homeland sec March 22, 20111

Bill No	Description	Companion Bills	Status
	for which an environmental impact statement (EIS) was required, and was originally constructed before the final EIS for the highway was completed.		
SB 1354	Amends Sub-chapter Z, Chapter 240 local government code by adding Section 240.908 regarding regulation of off-premise signs. Authorizes commissioner's court by order, to prohibit erection of an off-premise sign in an unincorporated area of county. Prohibits commissioner's court from requiring relocation, reconstruction, or removal of off-premise sign in existence.	HB 1360	Left pending in committee April 27, 2011
SB 1570	Amends Chapter 2267 relating to the sale of surplus land by a governmental entity to a private party. Allows government entity, without notice, or solicitation of bids to sell land it owns to a lessee for fair market value.	HB 1729	Left pending in committee May 12, 2011

Appendix II: Methodological Framework Inputs and Outputs

Step 1: Select the asset.

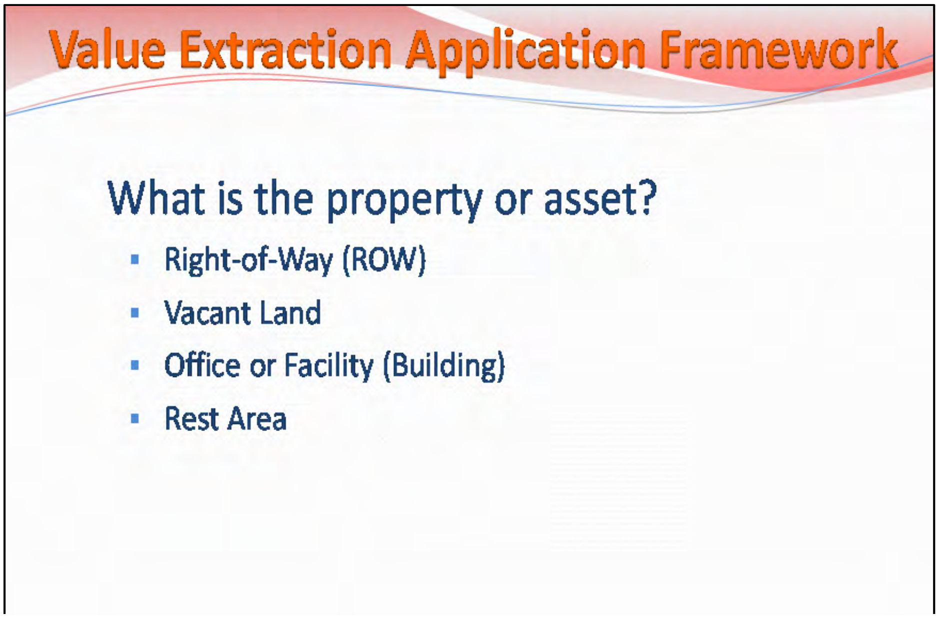


Figure II.1: Selection of type of asset

Step 2: Select the objective to be achieved.

Figure II.2: Selection of intended goal/objective

Step 3: List of questions to characterize the asset.

Value Extraction Application Framework

What are the characteristics of the vacant land?

1	Is the property in a prime real estate location?	Yes		No
2	Is the property in an urban center or commercial area or near a community center?	Yes		No
3	Is the property adjacent to or near a residential or commercial area?	Yes		No
4	Does the property have good easy access (or can access be secured)?	Yes		No
5	When will the property be developed (i.e., in how many years)?	< 5 yrs	5 yrs > < 20 yrs	>= 20 yrs
6	Is the property exposed to high traffic volumes?	Yes		No
7	How large (acres) is the property?	< 5 Acres		>= 5 Acres
8	Is the property on a flat terrain (or on a terrain with slope less than 20%)?	Yes		No
9	Does the property have good sun exposure (i.e., no sunlight obstruction)?	Yes		No
10	How far (miles) is the nearest a transmission line or electricity user/customer to the property?	< 1 mile		>= 1 mile
11	Is the property in a Competitive Renewable Energy Zone?	Yes		No
12	Is the property free of any wind obstructions (e.g., buildings, mountains, and hills)?	Yes		No
13	Is the property being mowed?	Yes		No
14	Can mowing of the property be halted?	Yes		No
15	What is the predominant vegetation on the property?	Grass	None	Tree
16	What is the average rainfall at the property?	< 15 in		>= 15 in
17	How far (miles) is the nearest biorefinery to the property?	=< 50 miles		> 50 miles

Figure II.3: Questionnaire to characterize the vacant land

Value Extraction Application Framework

What are the characteristics of the ROW?

1	How much ROW area (acres) besides the safety zone is available?	< 5 Acres		>= 5 Acres
2	What is the ROW width (feet) after excluding the safety zone?	< 10 ft		>= 10 ft
3	Is the ROW in a prime real estate location?	Yes		No
4	Is the ROW in an urban center or commercial area or near a community center?	Yes		No
5	When will the ROW be used (i.e., in how many years)?	< 5 yrs	5 yrs > < 20 yrs	>= 20 yrs
6	Does the site have good easy access (or can access be secured)?	Yes		No
7	Is the ROW exposed to high traffic volume?	Yes		No
8	Is the ROW on the Federal network?	Yes		No
9	Is the site on a flat terrain (or an terrain with a slope less than 20%)?	Yes		No
10	Is the site impacted by flooding, wetlands, or protected streams?	Yes		No
11	Has documented endangered or threatened flora or fauna been identified on or adjacent to the site?	Yes		No
12	Is the site on a designated state or federal scenic corridor or in a protected viewshed?	Yes		No
13	Have any cultural or historic artifacts been identified on or adjacent to the site?	Yes		No
14	Is this a site with a high occurrence of animal-vehicle-crash accidents?	Yes		No
15	Does the site have good sun exposure (i.e., no sunlight obstruction)?	Yes		No
16	How far (miles) is the nearest transmission lines or potential electricity user/customers to the site?	< 1 mile		>= 1 mile
17	Is the site adjacent to or near a residential or commercial area?	Yes		No
18	Is there any utility infrastructure on the site (including buried utilities)?	Yes		No
19	Is the ROW in a Competitive Renewable Energy Zone?	Yes		No
20	Is the site free of any wind obstructions (e.g., buildings, mountains, and hills)?	Yes		No
21	Is the ROW being mowed?	Yes		No
22	Can mowing of the ROW be halted?	Yes		No
23	What is the predominant vegetation on the site?	Grass	None	Tree
24	What is the average rainfall at the site?	< 15 in		>= 15 in
25	How far (miles) is the closest biorefinery?	=< 50 miles		> 50 miles
26	Does it snow/ice at this location?	Yes		No

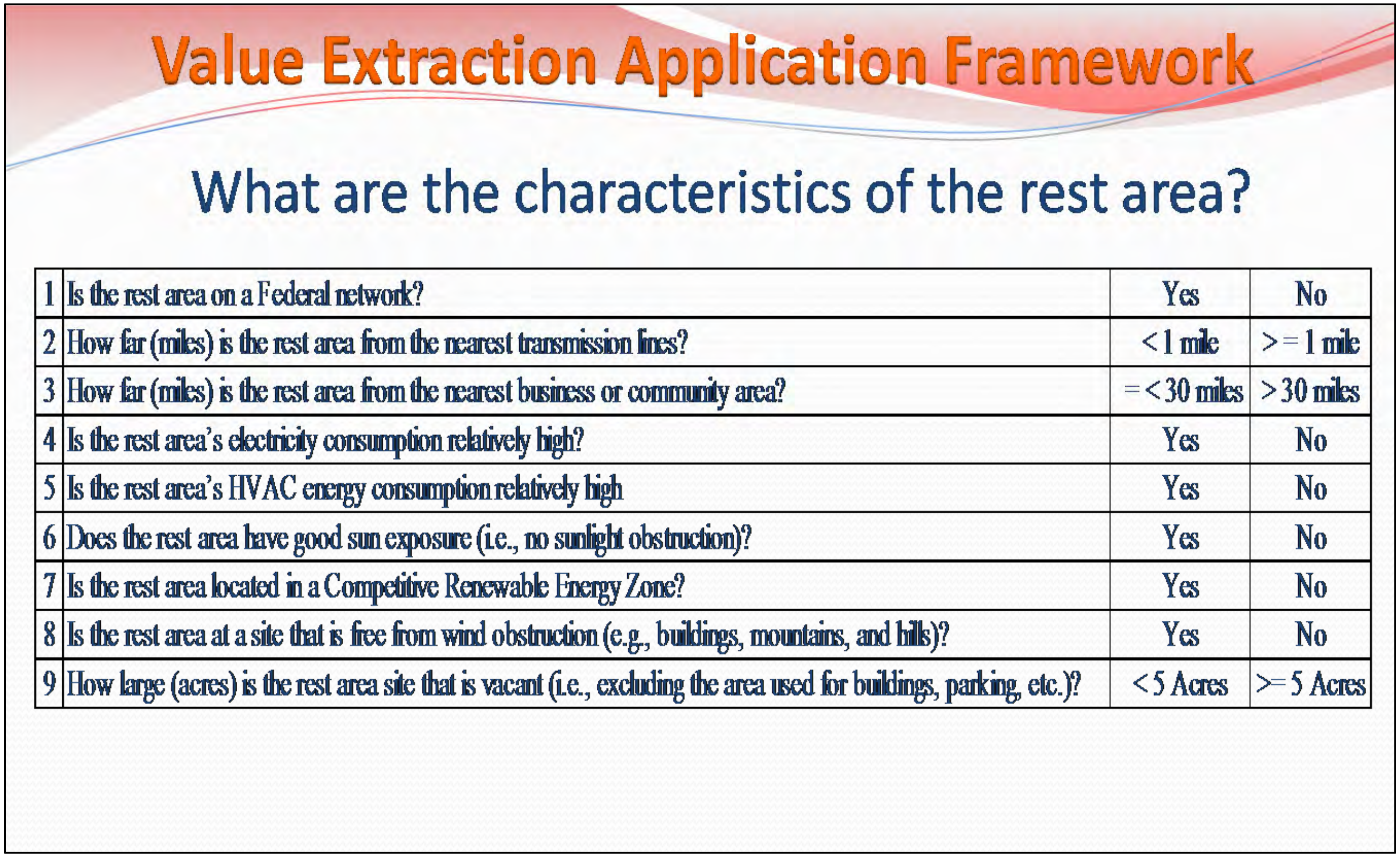
Figure II.4: Questionnaire to characterize the ROW

Value Extraction Application Framework

What are the characteristics of the office or facility?

1	Is the building in a prime real estate location?	Yes	No
2	Is the building in an urban center or residential or commercial area?	Yes	No
3	Is it an old building with high maintenance cost?	Yes	No
4	Is the building's electricity consumption relatively high?	Yes	No
5	Is the building's HVAC energy consumption relatively high?	Yes	No
6	Does the building have good sun exposure (i.e., no sunlight obstruction)?	Yes	No
7	Is the building in a Competitive Renewable Energy Zone?	Yes	No
8	Is the building at a site that is free from wind obstruction (e.g., other buildings, mountains, and hills)?	Yes	No
9	Is the building critical and essential to TxDOT's future operations (i.e., cannot be replaced)?	Yes	No
10	Is the building fully occupied and utilized?	Yes	No
11	Does the building site have any antenna tower or is there available area to install an antenna/radio tower at the site?	Yes	No
12	For how long does TxDOT plan to occupy and/or own the property?	< 20 yrs	> = 20 yrs

Figure II.5 Questionnaire to characterize the office or facility



1	Is the rest area on a Federal network?	Yes	No
2	How far (miles) is the rest area from the nearest transmission lines?	< 1 mile	>= 1 mile
3	How far (miles) is the rest area from the nearest business or community area?	=< 30 miles	> 30 miles
4	Is the rest area's electricity consumption relatively high?	Yes	No
5	Is the rest area's HVAC energy consumption relatively high	Yes	No
6	Does the rest area have good sun exposure (i.e., no sunlight obstruction)?	Yes	No
7	Is the rest area located in a Competitive Renewable Energy Zone?	Yes	No
8	Is the rest area at a site that is free from wind obstruction (e.g., buildings, mountains, and hills)?	Yes	No
9	How large (acres) is the rest area site that is vacant (i.e., excluding the area used for buildings, parking, etc.)?	< 5 Acres	>= 5 Acres

Figure II.6 Questionnaire to characterize the rest area

Step 5: List of VEAs that can potentially fulfill the objective.

Figure II.7: Potential VEAs (Vacant Land & Save Costs)

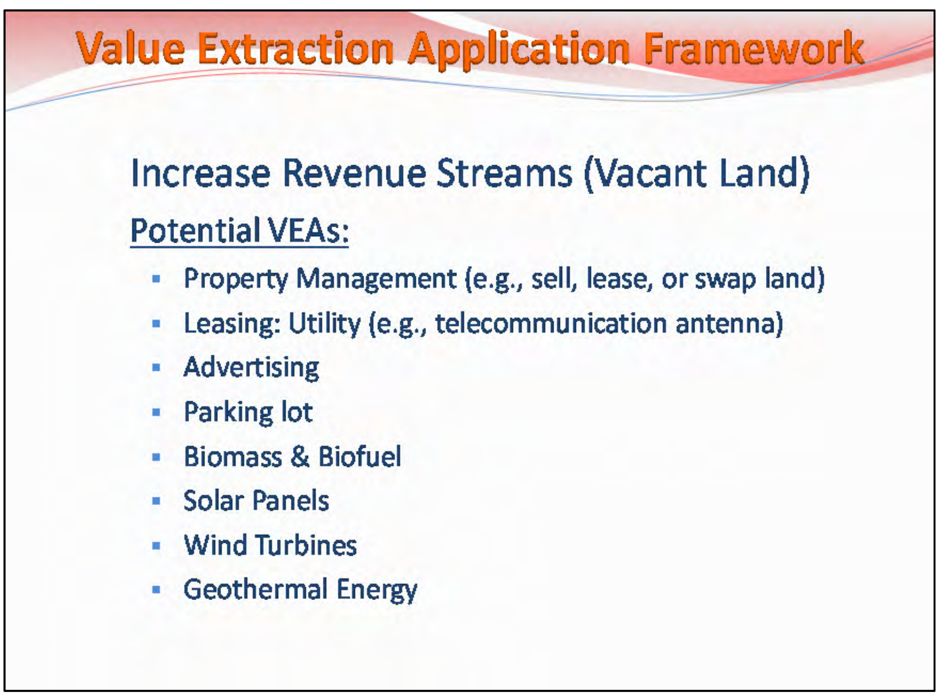


Figure II.8: Potential VEAs (Vacant Land & Increase Revenue Streams)

Figure II.9: Potential VEAs (Vacant Land & Enhance Societal Goals)

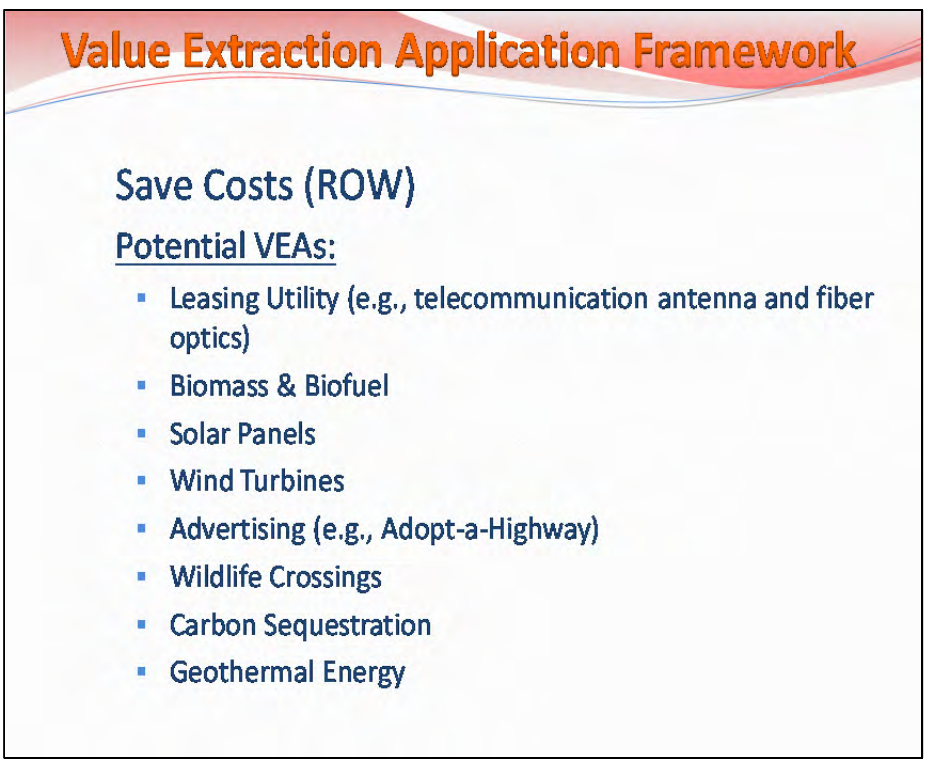


Figure II.10: Potential VEAs (ROW & Save Costs)

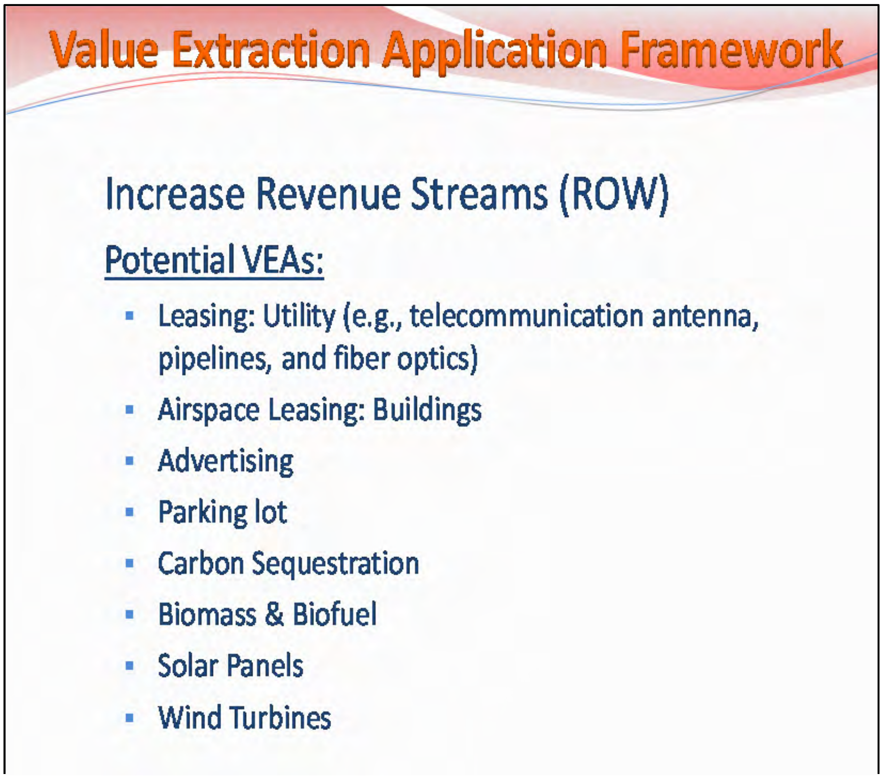


Figure II.11: Potential VEAs (ROW & Increase Revenue Streams)

Figure II.12: Potential VEAs (ROW & Enhance Societal Goals)

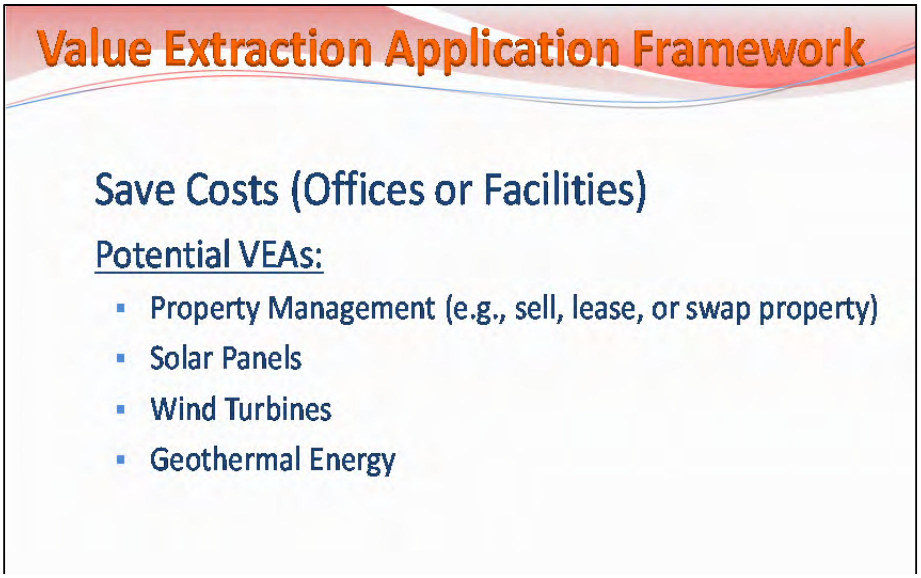


Figure II.13: Potential VEAs (Offices or Facilities & Save Costs)

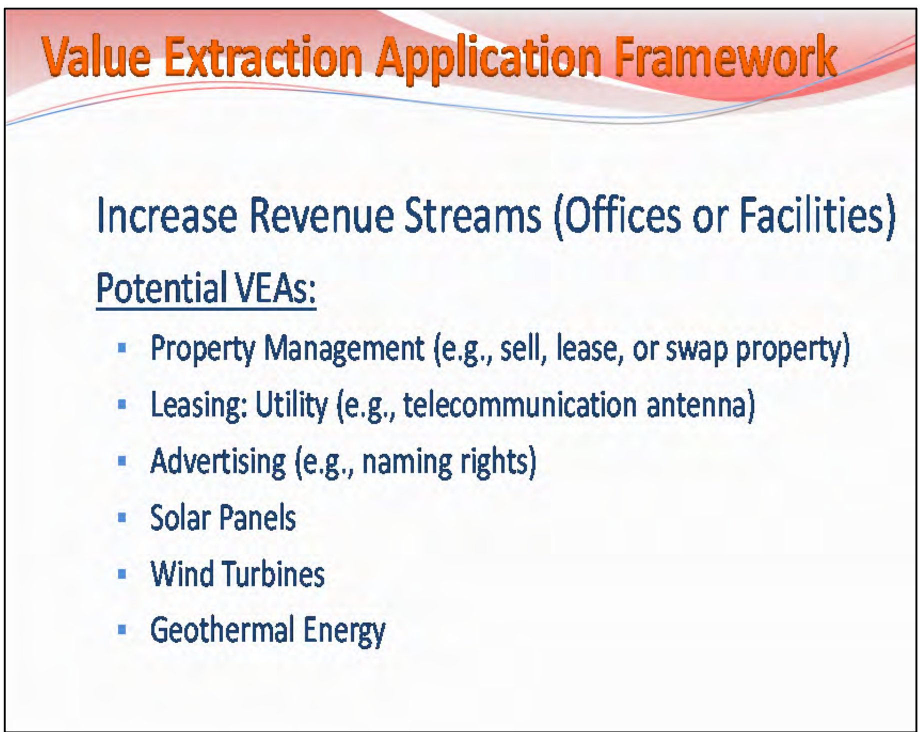


Figure II.14: Potential VEAs (Offices or Facilities & Increase Revenue Streams)

Figure II.15: Potential VEAs (Offices or Facilities & Enhance Societal Goals)

Figure II.16: Potential VEAs (Rest Area & Save Costs)

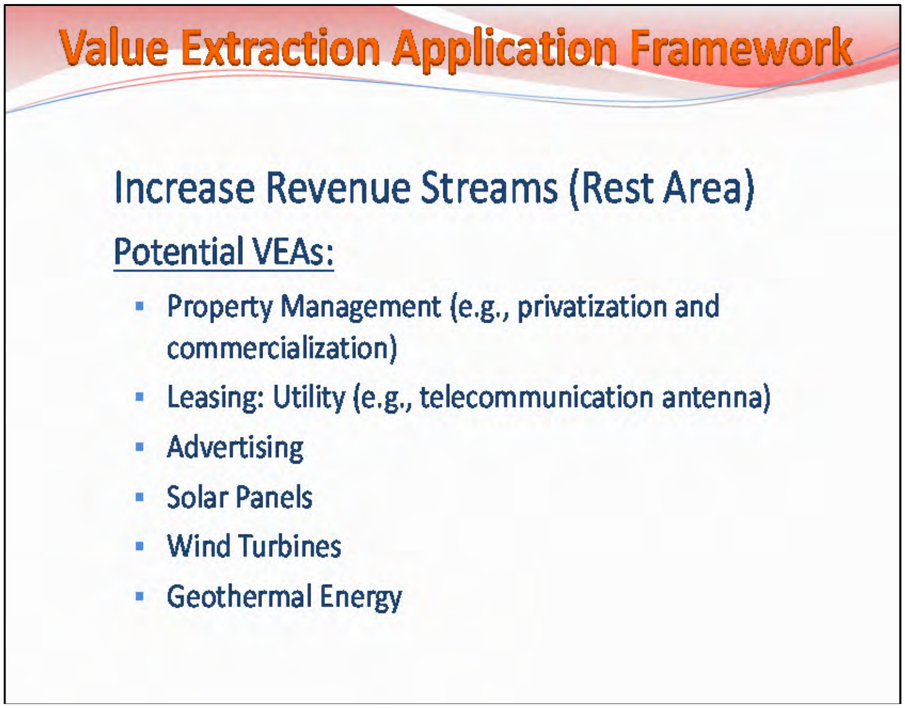


Figure II.17: Potential VEAs (Rest Area & Increase Revenue Streams)

Figure II.18: Potential VEAs (Rest Area & Enhance Societal Goals)

Step 8: List of Advantages & Disadvantages/requirements

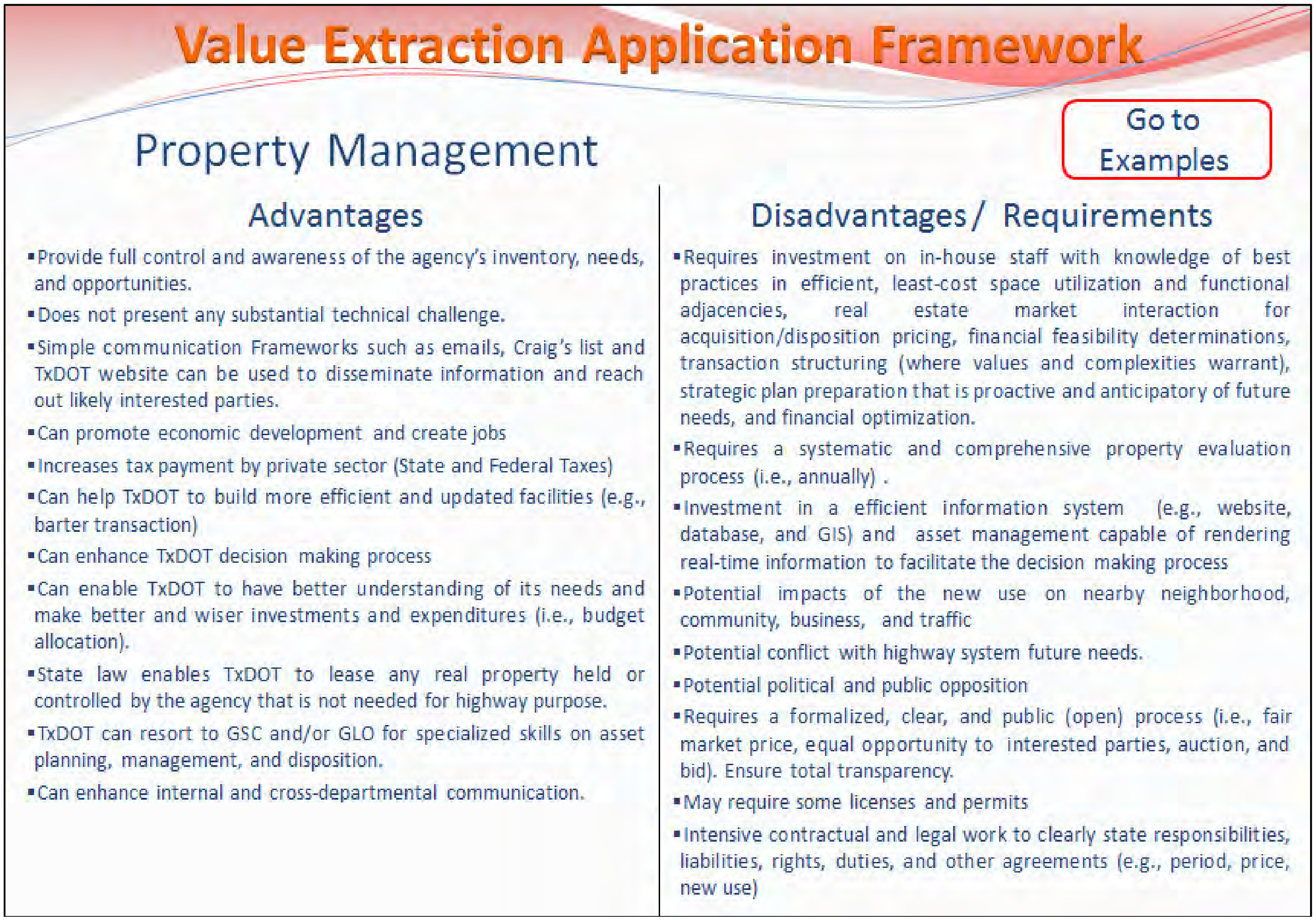


Figure II.19: Adv. and Disadv./Req. of Property Management

Value Extraction Application Framework

Go to Examples

Property Management (Rest Area)

Advantages

- Can avoid closure of or even increase the number of rest areas.
- Can provide cleaner and safer rest areas (i.e., hygiene and security)
- Can enhance the service on rest areas (e.g., ATM, gas station, and food).
- Rest Areas are essential for road safety and trip quality .
- Can enhance road safety (i.e., reduction of accident due "drowsing" drivers).
- Is a simple value extraction application and does not demand any complex technical solution and/or high investment by TxDOT
- Attractive and useful rest areas encourage travelers to use a safe location off the roadway to take a break and return more alert to the highway.
- Can promote economic development and create jobs (i.e., when it does not compete with nearby business).
- Well served and interactive rest areas and welcome centers can potentially enhance the tourism market, create jobs and, therefore, help to develop rural regions (i.e., through the improvement of the quality of road trips).
- Increases Federal and State tax incomes (i.e., from private businesses and commercial activities).

Disadvantages/ Requirements

- Potential political and public opposition (i.e., can be controversial).
- Potential impacts on nearby neighborhood, community, and business (i.e., economical impacts and unfair competition)
- Federal and States laws and regulations that precludes or prohibits private and commercial rest areas
- Require investment on staff to manage, control, and oversee private rest area design, construction, and operation (i.e., compliance with standards, specifications, and requirements)
- Interference with current social projects, such as " blind vendor support"
- Need to assess best location according to traffic, access, environment, and construction requirements
- Need an intensive traffic flow to be financial attractive to private sector. Hence, it will not solve the problems in very remote areas
- Requires a formalized, clear, and public (open) process (i.e., fair market price, equal right to all interested parties, auction, and bid)
- May require licenses and permits, mainly environmental.
- Intensive contractual and legal work to clearly state responsibilities, liabilities, rights, duties, and other agreements (e.g., period, price, new use)

Figure II.20: Adv. and Disadv./Req. of Property Management (Rest Area)

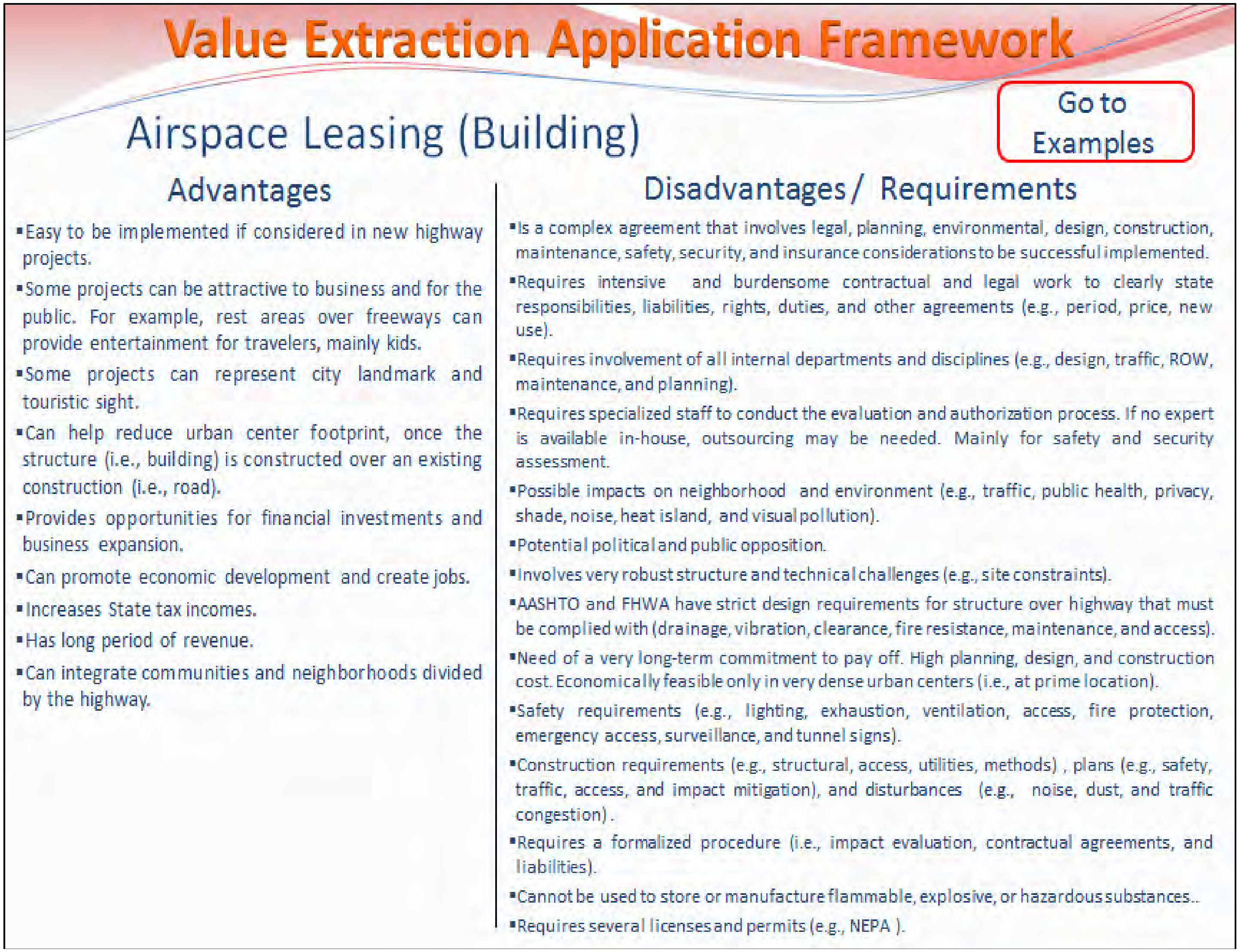


Figure II.21: Adv. and Disadv./Req. of Airspace Leasing (Building)

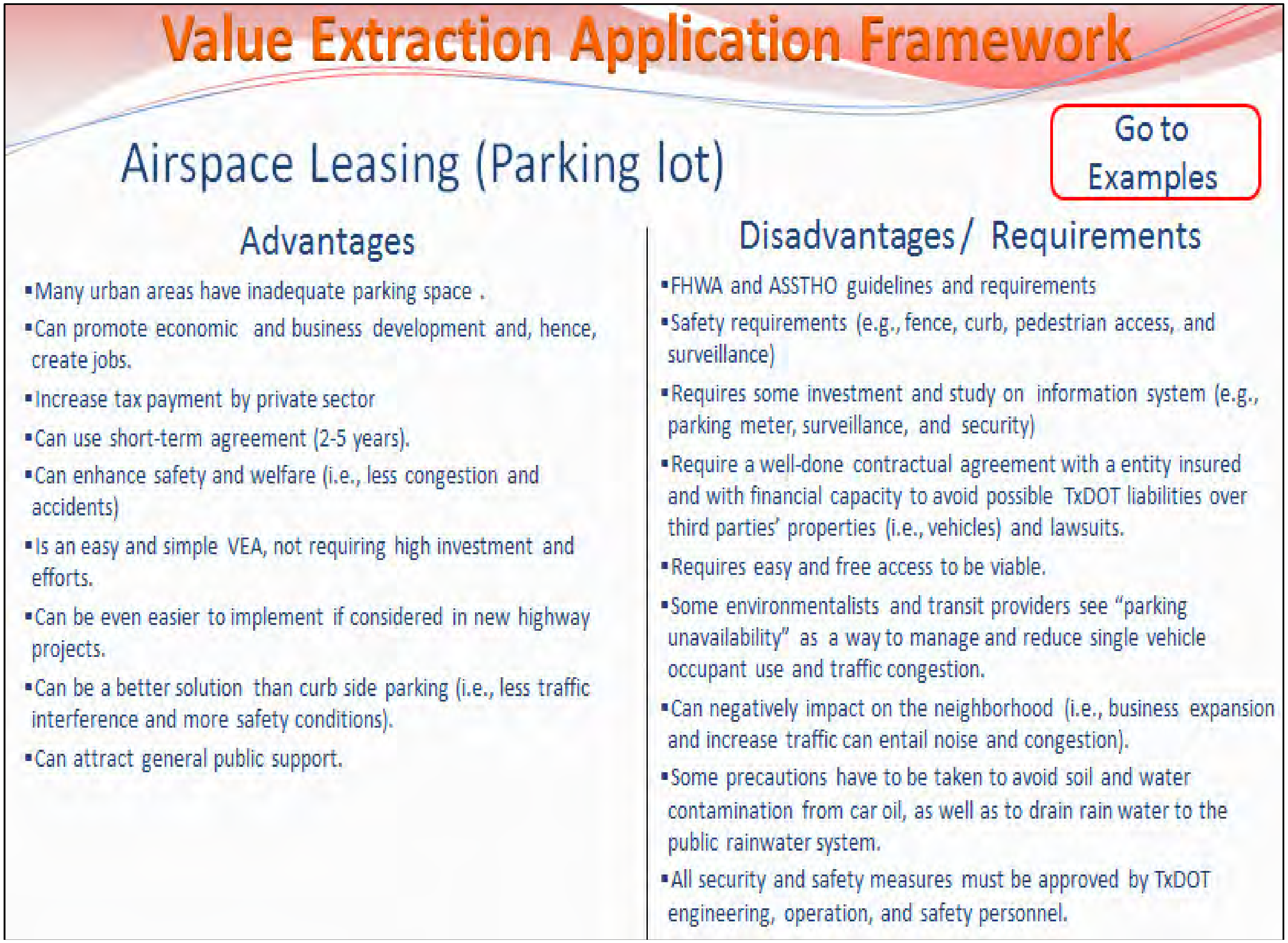


Figure II.22: Adv. and Disadv./Req. of Airspace Leasing (Parking Lot)

Value Extraction Application Framework

Go to Examples

Airspace Leasing (Utilities)

Advantages

- Enhanced and available telecommunication signals can contribute to social and educational development, as well as help promote economic development and create jobs.
- Can enhance safety in remote area (e.g., tornado warming, communication of animal carcass, existing obstacle, pavement conditions, and severe weather conditions).
- Several potential ways to implement this VEA.
- Can be even easier to implement if considered in new highway projects.
- Can provide the State access to technology infrastructure.
- Can yield a better telecommunication network, helping TxDOT and other public agencies to improve their information management systems and, consequently, enhance their services, implement an efficient maintenance program, and make better decision (i.e., wisely spend public money).
- TxDOT already has some airspace agreements for utilities that generate revenue, but not a formalized program. A formal program could bring more contracts and revenue for the agency and State.
- Some application can be implemented with a short-term agreement (5 years)
- Can facilitate the implementation or expansion of TxDOT's Advanced Rural Transportation System (ARTS) , Dynamic Message Signs, 511 travel information, and Highway Advisory Radio.

Disadvantages / Requirements

- Requires license and permits such as environmental
- Need to comply with FHWA and ASSTHO guidelines and requirements, as well as NEPA. Some policies may be out of date and not address new technologies.
- Importance of contractual agreement (i.e., liabilities and responsibilities) and legal consul during the process.
- Only applicable to private utilities
- Some utilities can entail safety and environmental concerns (e.g., explosion, contamination, leak, and crash)
- May cause traffic disruption and hazardous situation during construction and maintenance . Importance of good planning and assessment, as well as access to the site.
- FHWA requires environmental evaluation and compliance with NEPA
- Requires a formalized, clear, and public (open) process (i.e., fair market price, equal right to all interested parties, auction and bid, specifications, and guidelines)
- Requires a construction and maintenance plan (i.e., access, minimize impacts on traffic, safety, and execution method)
- Some application requires special considerations such as, buried depth, concrete coat, and reinforcement.
- Private companies will need to have free or partial access to ROW or public properties.
- May compete with private sector (e.g. tower companies).

Figure II.23: Adv. and Disadv./Req. of Airspace Leasing (Utilities)

Value Extraction Application Framework

Go to Examples

Advertising

Advantages

- Is significantly simple application and provides several means to be implemented.
- Has a diversified portfolio of applications.
- Can be used to educate, warn, and guide drivers toward safer behavior (e.g., " drink-and-drive", "no texting", and "buckle-up").
- Can be used to conduct public outreach , disseminate information, integrate communities, engage public participation, and share ideas.
- Can help to promote businesses , tourism activities, and, hence, economic development (mainly in rural areas).
- New technologies provide good potential and alternative to implement this VEA (e.g., website, internet, electronic screens, and TVs).
- Does not cause any environmental threat or impact.
- Programs, such as Adopt-a-Highway, can make roadside litter-free, helping to preserve fauna and flora, to avoid soil and water contamination, prevent insect proliferation and, consequently, diseases, and generate local employment.
- Programs, such as Adopt-a-Watt, Adopt-a-Highway, and Naming Rights, can foster and facilitate the implementation of other value extraction applications.

Disadvantages / Requirements

- Some sort of advertising are illegal and others are regulated and/or restricted by FHWA.
- Potential political and public opposition
- Some advertising (i.e., message and content) can be controversial and lead to misinterpretation.
- Demand some precaution with controversial advertisings.
- Different regulations and laws that dictate and control the use of advertising in public assets and highway ROW.
- May require some license or permit.
- May cause visual impacts (aesthetic) .
- May impact on and/or be in conflict with Texas Highway Beautification Act (HBA) and State Rural Roads Act (RRA).
- High administration cost (e.g., intensive contractual and paper work).
- Requires several "small" contracts to offset the administrative costs.
- May entail safety concerns (e.g., driver distraction and obstacle).
- Requires a formalized, clear, and public (open) process (i.e., fair market price, equal right to all interested parties, auction and bid, specifications, and guidelines).

Figure II.24: Adv. and Disadv./Req. of Advertising

Value Extraction Application Framework

Solar Panel (ROW and Vacant Land)

Go to Examples

Advantages

- Has no moving part, does not require water, does no make noise, and does not produce any waste or GHG emission.
- Solar energy is a key component of the U.S. national strategy for reducing carbon footprint and promoting renewable energy.
- Texas has a great solar energy potential.
- Renewable energy has gained momentum due to "an increase in environmental awareness, skyrocket oil and gas price, and national security concerns". Also, can protect the agency against oil price volatility.
- Texas energy production has not followed the State energy demand (i.e., consumption).
- Can help to reduce the dependence on fossil fuels and foreign energy.
- Using a value-based procurement (local vendors, maintenance expert, and workers) can promote economic development and create jobs.
- The technology is still evolving and becoming cheaper and more efficient
- Can be installed close to the end-user and with any scale (i.e., size), therefore not requiring long transmission lines and reducing heat loss – mainly in remote areas.
- Is a environmentally-friendly energy source and can generate electricity without disturbing the surrounding environment or community.
- Can enhance TxDOT image and bring political and public support.
- Is easy to implement if considered in highway new projects.
- Has low maintenance frequency and cost. Further, vendors provide 25-year warranty.
- Existing incentives granted by state and federal governments and REC credits.
- Can help TxDOT meet carbon emission and renewable energy consumption goals.
- The panels can be recycled.
- Solar energy is a safe source of electricity (i.e., does not pose any risk of explosion, fire, disasters, structural failure, or accidents).
- Can promote awareness and educate general public on green energy, importance of carbon reduction, and renewable energy.

Disadvantages / Requirements

- Feasibility and efficiency is very local-driven.
- Require a high up-front investment, what entails a long payback and commitment period.
- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities).
- Involves a public-private-partnership, therefore an intensive and burdensome contractual and legal work.
- Can use several, but complex, business models that vary according to the shared risks, liabilities, electricity buyer, and renewable energy credits.
- Has some patent issues.
- May cause some impacts on nearby communities (i.e., property value).
- Works only during the day (i.e., sunlight); otherwise need batteries or other electricity source.
- Relies upon the weather conditions, requiring batteries or other electricity source for more reliability
- Requires a clean, easy, independent, and safe access (i.e., aside the main road).
- Must comply with FHWA and ASSTHO regulations regarding the use of ROW.
- May need some security precaution against theft and vandalism
- Require considerations and a plan on the solar panel disposal, once the panels are composed by heavy metals, such as cadmium. Need a recycle program.
- May raise some safety concerns (e.g., roadside obstruction and driver's distraction), but site or guardrail can resolve these issues.
- Zoning law can preclude or impede the implementation.
- Has a low energy density production (i.e., requires somewhat area)
- Is still driven by incentives.
- May impact on Texas Highway Beautification Act.

Figure II.25: Adv. and Disadv./Req. of Solar Panel (ROW/Vacant Land)

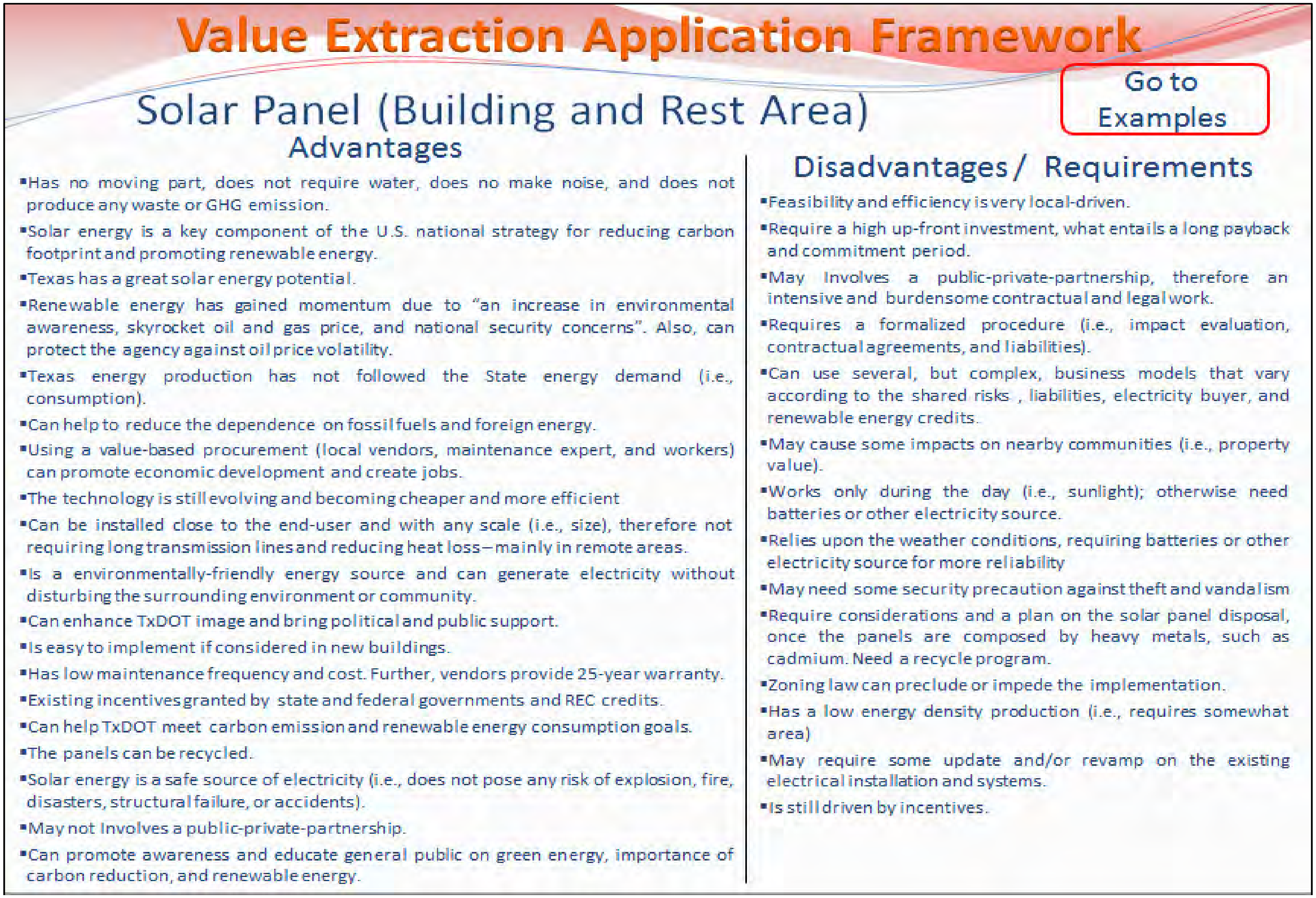


Figure II.26: Adv. and Disadv./Req. of Solar Panel (Building/Rest Area)

Value Extraction Application Framework

Wind Turbine (ROW and Vacant Land)

Go to Examples

Advantages

- Some regions of Texas (i.e., CREZ) has a great wind energy potential
- New technologies (i.e., small wind turbines) can help to overcome space issues, reduce up-front investment, and others barriers.
- Has high electricity production per area
- Does not require water and does not produce any waste or GHG emission.
- Can generate energy any time of the day.
- Wind turbine is a key component of the U.S. national strategy for reducing carbon footprint and promoting renewable energy.
- Renewable energy has gained momentum due to "an increase in environmental awareness, skyrocket oil and gas price, and national security concerns". Also, can protect the agency against oil price volatility.
- Texas energy production has not followed the State energy demand (i.e., consumption).
- Can help to reduce the dependence on fossil fuels and foreign energy.
- Using a value-based procurement (local vendors, maintenance expert, and workers) can promote economic development and create jobs.
- The technology is still evolving and becoming cheaper and more efficient
- Can be installed close to the end-user and with any scale (i.e., size), therefore not requiring long transmission lines and reducing heat loss – mainly in remote areas.
- Is a environmentally-friendly energy source
- Can enhance TxDOT image and bring political and public support.
- Is easy to implement if considered in highway new projects.
- Existing incentives granted by state and federal governments and REC credits.
- Can help TxDOT meet carbon emission and renewable energy consumption goals.
- Can promote awareness and educate general public on green energy, importance of carbon reduction, and renewable energy.
- Is more cost-efficient than other renewable energy source (i.e., $ per KWh generated) and is still evolving.
- Involves intense work-force, contributing thus for employment.

Disadvantages / Requirements

- Feasibility and efficiency (i.e., energy production) is very local-driven.
- Can highly impacts on nearby communities and environment (e.g., property value, noise, bird kill, shade, oil leaks, visual aesthetics, tourism, public safety, and quality of life, visual intrusion, and flickering of light)
- Has somewhat intensive maintenance
- Need of construction and maintenance plan (i.e., transport, minimal distance between turbines, installation, access and maintenance procedures). Can potentially impact on traffic and road structure.
- Require a high up-front investment, what entails a long payback and commitment period.
- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities).
- Involves a public-private-partnership, therefore an intensive and burdensome contractual and legal work.
- Can use several, but complex, business models that vary according to the shared risks , liabilities, electricity buyer, and renewable energy credits.
- Has some patent issues.
- May cause some impacts on nearby communities (i.e., property value).
- Relies somewhat upon the weather conditions , requiring batteries or other electricity source for more reliability
- May impact on Texas Highway Beautification Act.
- Requires a clean, easy, independent, and safe access (i.e., aside the main road).
- Must comply with FHWA and ASSTHO regulations regarding the use of ROW.
- May raise some safety concerns (e.g., roadside obstruction, blade failure, oil spill on the road, turbine catching on fire, and driver's distraction), but site can resolve these issues.
- Zoning law can preclude or impede the implementation (e.g., height limit).
- The wind turbine/system must comply with local electrical code requirements, the National Electrical Code (NEC), and Fire Protection Association.
- May require some licenses and permits (e.g., FAA permit)
- Can interfere on telecommunication, radio, internet, TV, and radar signals
- Is still driven by incentives.

Figure II.27: Adv. and Disadv./Req. of Wind Turbine (ROW/Vacant Land)

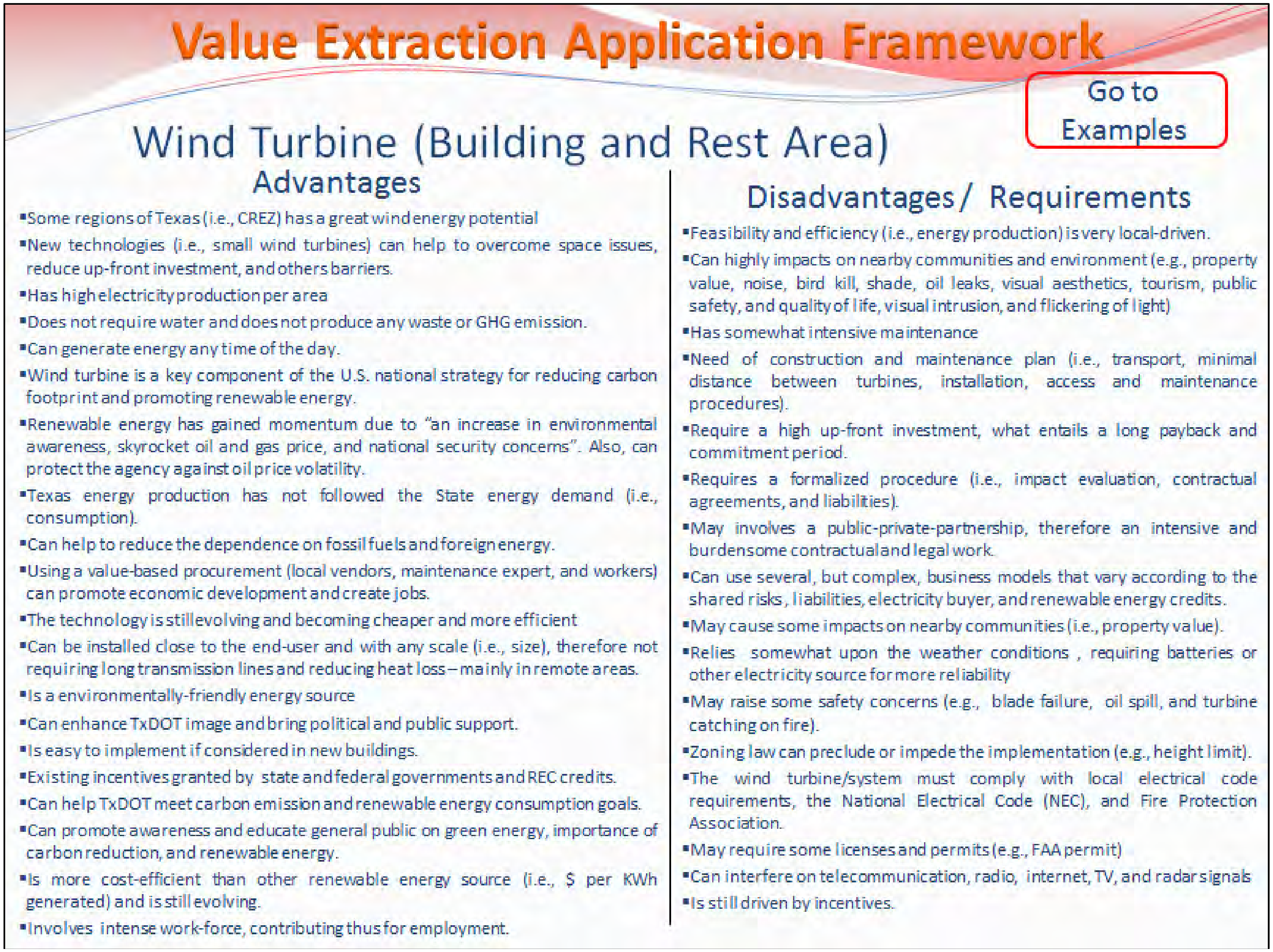


Figure II.28: Adv. and Disadv./Req. of Wind Turbine (Building/Facility)

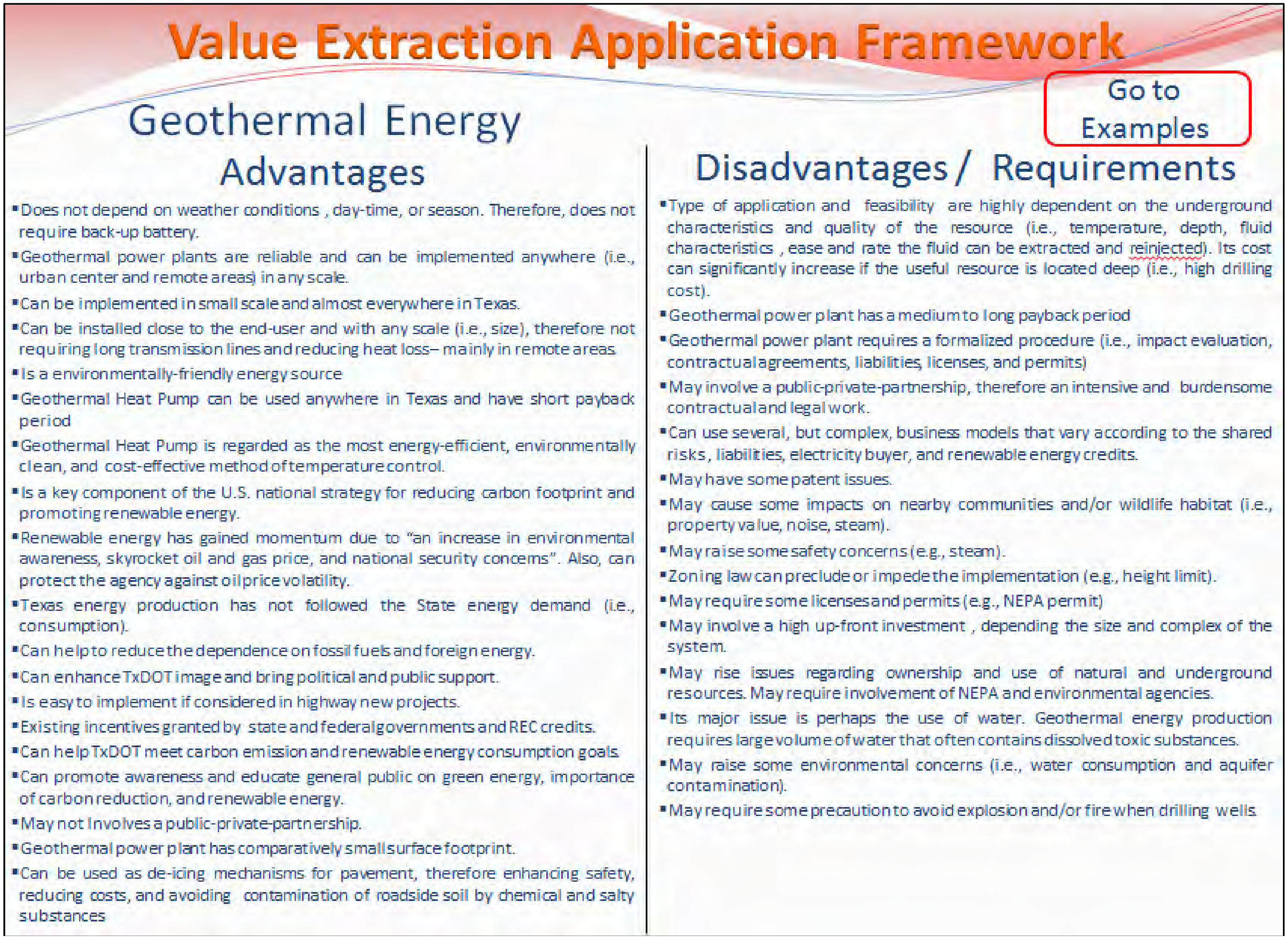


Figure II.29: Adv. and Disadv./Req. of Geothermal Energy

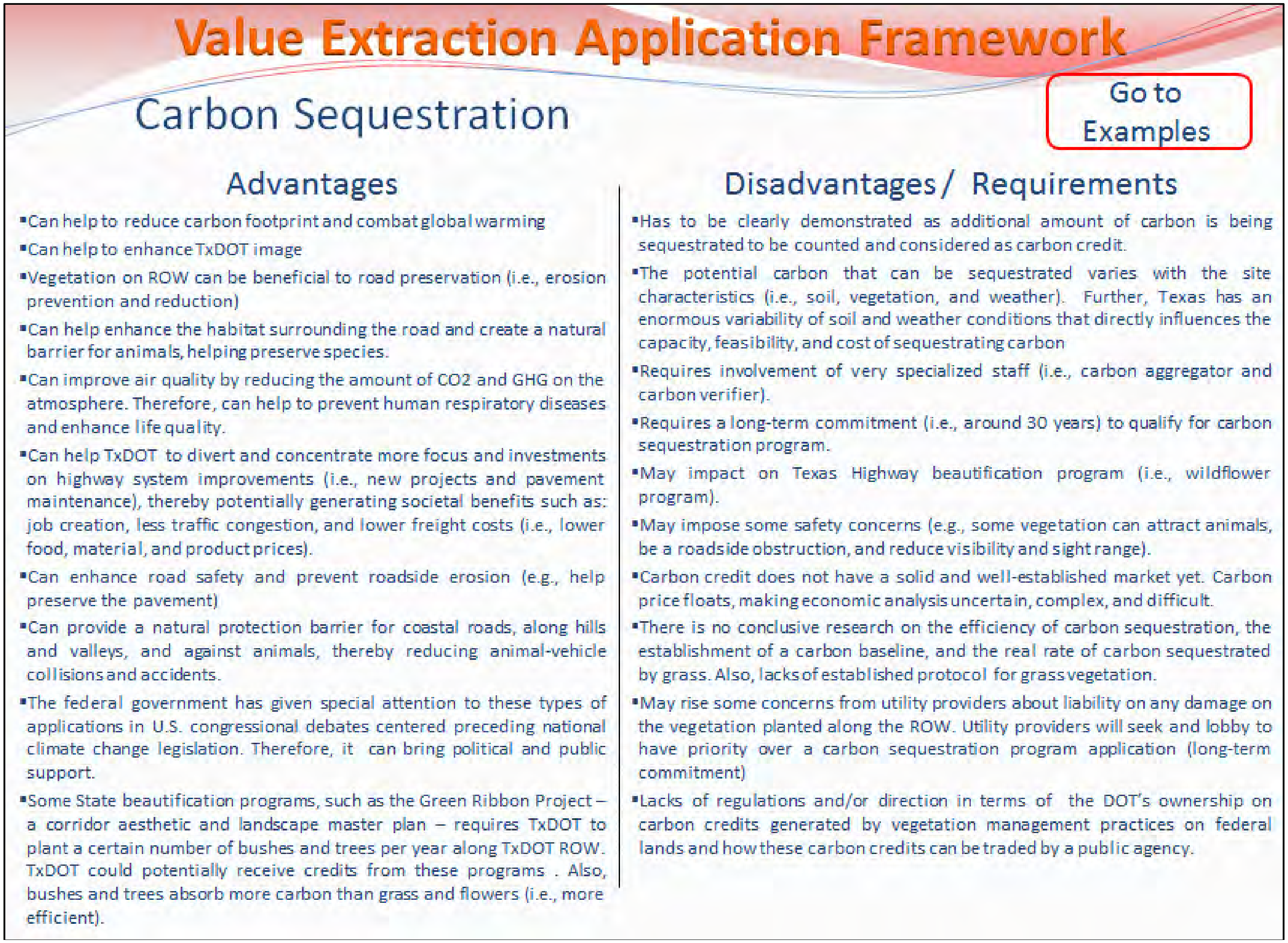


Figure II.30: Adv. and Disadv./Req. of Carbon Sequestration

Value Extraction Application Framework

Go to Examples

Biomass and Biofuel

Advantages

- Texas contains one of the most diverse and most accommodating growing environments in the United States, and boasts a plethora of potential biomass-based renewable energy sources.
- The areas along the Gulf Coast and Northeast have the highest potential for biomass production because of existing refining capacity, strong producer networks, and available fertile land.
- Can promote economic development and create jobs
- The equipment used is similar to mowing equipment.
- Activities undertaken are very similar to mowing activities.
- Can produce biofuel without competing with food market.
- Can reduce and solve roadside maintenance and pest control problems.
- Requires low up-front investment
- Vegetation on ROW can be beneficial to road preservation (i.e., erosion prevention and reduction). Also, a good vegetation management strategy enhances road safety and prevents erosion. Vegetation along highway ROW defers erosion by reducing landslides, controlling evasive plant species, retaining stormwater, and holding snow (i.e., living snow fence).
- Same precautions and traffic control used to mowing activities can be adopted to plant and harvest crops.
- Biofuel combustion emits considerable less carbon than fossil fuel.
- The ethanol and biodiesel market has gained prominence worldwide due to increasing fossil fuel prices and pollution concerns.
- Can help to avoid the expansion of farming into environmentally sensitive areas; a commonly challenge found with conventional biofuel production
- Biofuel is non-toxic to humans and animals as well as biodegradable (i.e., disposal and waste are absorbed by the environment without being polluting).
- Using DOT ROW for biomass production can thus reduce the need for using farm land for energy crop production; thereby alleviating pressure on food and other commodities' price.

Disadvantages / Requirements

- Its feasibility and productivity (cost-effectiveness) depends on soil and weather conditions. Further, the production of each specific crop will largely be determined by available land, rainfall, competition, producer interest, economic incentives, and equipment needed.
- Water availability is crucial for most agriculture activity . It is generally believed that it would be very difficult to cultivate crops for biofuel production in areas with less than 14 to 16 inches of rainfall
- Logistic considerations (e.g., planting, harvesting, transporting, biorefinery, and access)
- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities). Also, questions about how to establish the business models and explore agricultural activities on public lands.
- May rise some concerns from utility providers about liability on any damage on the vegetation planted along the ROW. Utility providers will seek and lobby to have priority over a biomass production application (long-term commitment).
- May require intensive coordination with utility providers and agricultural activities – such as, plowing, tilling, harvesting, and mowing. Vegetation roots may impact on underground utilities (e.g., gas lines, oil lines, electricity, telephone, water, and fiber optics) that are also using the ROW. Contractual and legal issues with responsibilities and liabilities
- The use of de-icing products (e.g., salt) and run-off water can affect and change the proprieties of the soil in the ROW, hindering the growth of crops.
- Some crops and vegetation (e.g., switchgrass) has notorious difficult for establishment . Some takes up to 3years, even when some chemical fertilizers were used.
- Investment in a GIS database that captures the geospatial characteristics of TxDOT's ROW would aid in the identification and determination of which ROW parcels are appropriate for biomass production.
- May compete with and/or affects the ongoing roadside beautification and wildflower programs. Some crops do not promote the same aesthetical effect the flowers that integrate these programs have.
- Involves several variables and uncertainties, making the economic analysis complex and unique for each circumstance.
- In Texas, the ethanol and biodiesel market is not as prominent partly because grain has mostly been produced for animal – mostly cattle – consumption.
- May impose some safety concerns (e.g., some vegetation can attract animals, be a roadside obstruction, and reduce visibility and sight range).
- Licenses and permits required to exploit public land for agricultural activities.
- Has to comply with FHWA and ASSTHO regulations.

Figure II.31: Adv. and Disadv./Req. of Biomass & Biofuel

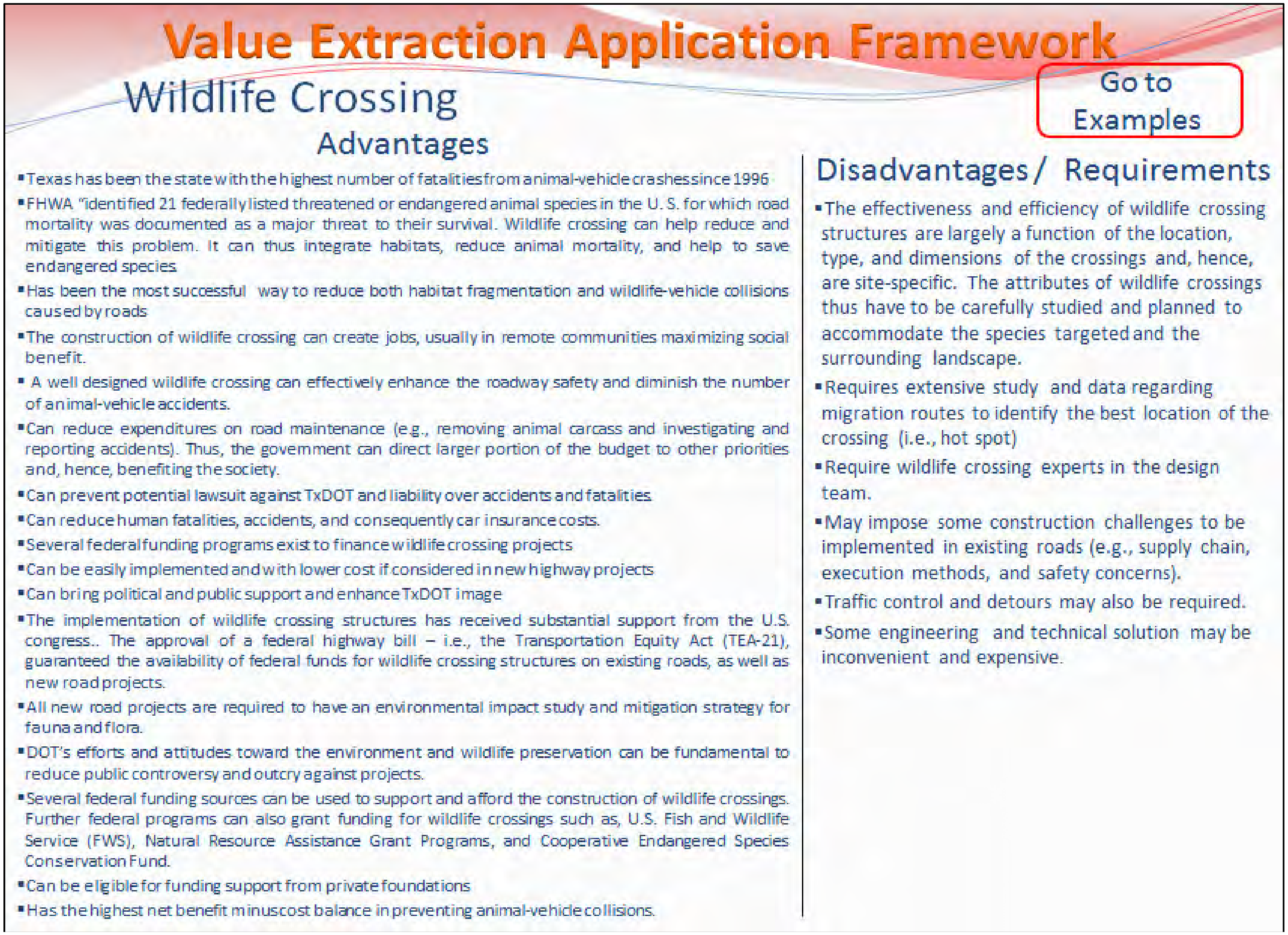


Figure II.32: Adv. and Disadv./Req. of Wildlife Crossing

Step 9: Summary of examples

Figure II.33: Examples of Property Management

Figure II.34: Examples of Property Management (Rest Area)

Value Extraction Application Framework

Examples: Airspace Leasing (Building)

Go to Technical Memorandum

In Boston, the airspace over the Massachusetts Turnpike holds at least three formalized airspace leasing agreements for buildings, which have been topic of research, inclusively. The first is the Copley Place, a 3.5 million square-feet complex constructed in 1986 that comprises hotel, retail store, office, parking and housing. The second in Columbus Center, a complex of buildings that occupies 7 acres divided into 4 parcels of air rights and totalizes 1.4 million square-feet of construction. The Columbus Center consists of hotel, restaurant, retail store, health club, residential building, and parking. The last is The One Kenmore that occupies 1 parcel of airspace and is still in development. When concluded, The One Kenmore will have 1.2 million square-feet of construction, including office, health club, grocery store, community center, and parking. The economic feasibility of all three projects was ensured by an airspace premium funding granted by the City of Boston. This fund was needed because the land value in Boston in the outset of the projects was not yet high to spark and encourage private investment. In terms of benefits, the City of Boston could reconnect the neighbors that have been divided by the highway corridor, generate new tax revenue, and create permanent jobs with the economic development.

Figure II.35: Examples of Airspace Leasing (Building)

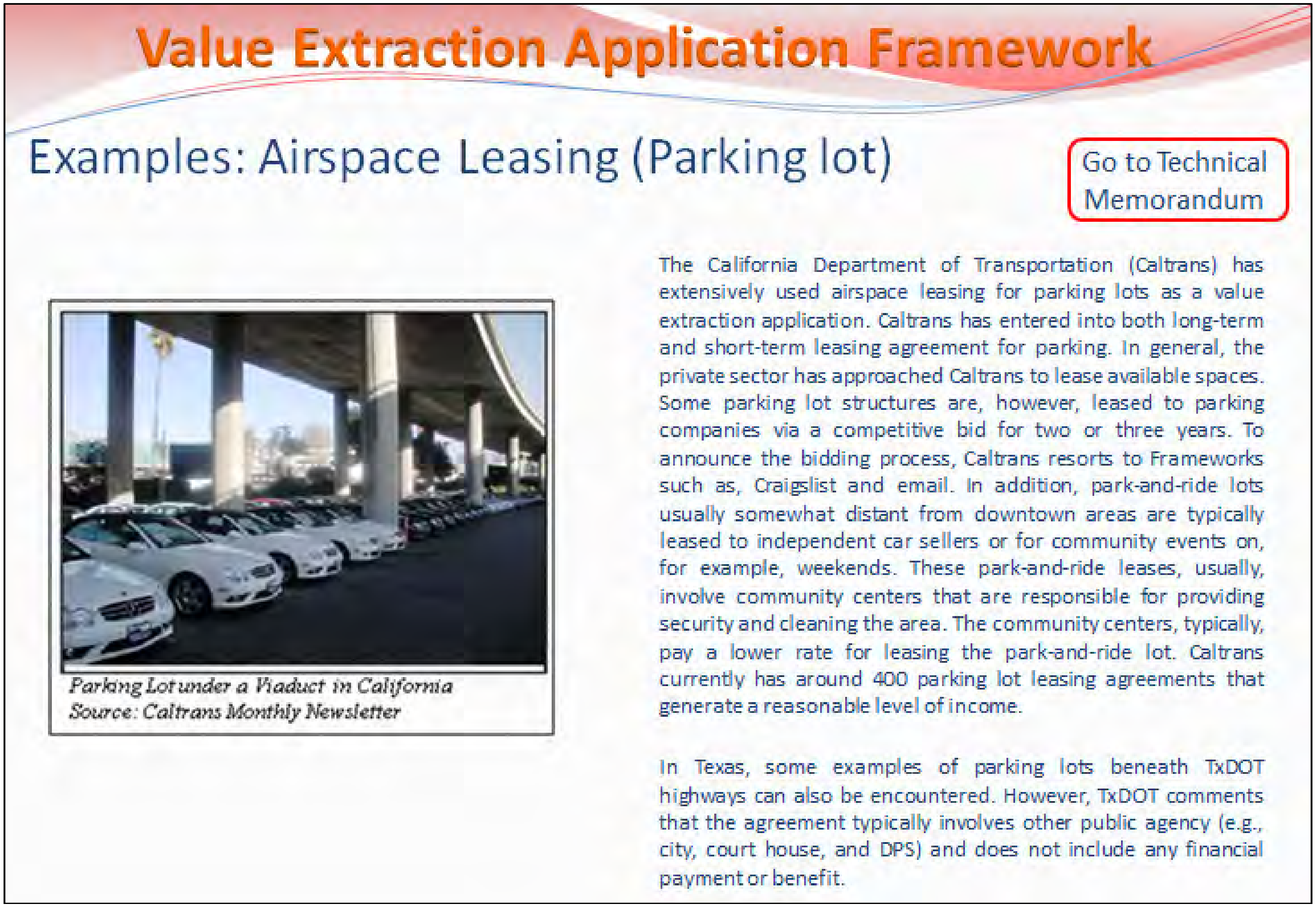


Figure II.36: Examples of Airspace Leasing (Parking Lot)

Value Extraction Application Framework

Examples: Airspace Leasing (Utilities)

Go to Technical Memorandum

In 1999, "The Florida DOT reached a 30-year lease agreement with Lodestar Towers, Inc., allowing Lodestar Towers, Inc. to lease access to the Department's limited access rights-of-way in return for compensation formulated as a percentage of the gross revenues received from renting antenna space to commercial wireless service providers". The public private lease agreement was developed in compliance with the Department's Telecommunications Policy, whose goal is "to consolidate wireless tower use to the Department's limited access rights-of-way by providing equal access and opportunity to all wireless service providers. This strategy encourages wireless service providers to collocate on towers located on the Department's limited access rights-of-way instead of developing numerous new tower sites in local communities. The resulting reduction of the number of towers and the location of needed towers as far from residential areas as possible facilitates the intent of the lease to support the wireless service providers while minimizing wireless tower proliferation". "To date, Lodestar Towers, Inc. has constructed 26 towers on the Department's rights-of-way. Another 22 proposed towers are under siting and design review by the Department" (Florida ITS, 2001).

Wireless monopole with an electrical vault and fencing. To

The California Department of Transportation (Caltrans) received $7.3 million in revenue in FY 2008 from its airspace leasing program, of which $1.3 million came from 52 cell towers (Caltrans, 2009). Caltrans's Leasing Program Administration personnel regard the cost-effectiveness of cell towers to be a major benefit. Cell towers do not require extensive maintenance on the sites and generate reasonable revenues (Caltrans, 2009). Caltrans's Airspace program for telecommunications is administrated by an agent and five-person team that are responsible for managing the relationship with renters, seeking business opportunities, and implementing the procedures needed for leasing (Caltrans, 2009). Most of the airspace leasing agreements involve telecommunication providers, which encompass 20 different companies. Most of the telecommunication leasing agreements are located in urban areas (about 90%) and all of them are in accordance with the Caltrans's master license agreement that grants a 5 year license for a specific site, with the option to renew the license five times for 5 years each.

In Texas, TxDOT estimates to receive between $2 million to $4 million from an informal and inactive program. TxDOT also believes that formalizing this program could bring more management efficiency and incomes to the state.

Figure II.37: Examples of Airspace Leasing (Utilities)

Figure II.38: Examples of Advertising

Figure II.39: Examples of Advertising

Value Extraction Application Framework

Go to Technical Memorandum

Examples: Solar Panel (ROW and Vacant Land)

Oregon DOT (ODOT) is the pioneer in implementing solar panels in highway ROW. In December 2008, ODOT concluded the installation of the first solar arrays project at the interchange of IH-5 (see figure 5.8). The arrays can produce up to 117 KWh annually, i.e., 1/3 of the energy needed on the site. Basically, the solar arrays feed the grid with the electricity produced during the day whereas at night the grid supplies the electricity for interchange lighting.

Currently, SMUD Sacramento (California) is exploring a 594 solar panels project. Also, Caltrans is analyzing the feasibility of installing solar charge stations for electrical vehicles along highways, as well as the installation of solar panels for light poles.

In 2010 the Ohio DOT, in conjunction with the University of Toledo, installed a 100KW solar array – composed by 966 rigid solar panels and 198 flexible solar panels – in the ROW off IH-280 and Greenbelt Parkway in Toledo, OH. The solar array provide the entire electricity demanded at the Veteran's Glass City Skyway Bridge, which has a 196-foot lighted pylon containing 384 light emitting diode fixtures

A number of solar projects can be found in European and Oceania transportation ROW. Germany, for example, has invested € 11 million in a solar panel project on top of a tunnel on highway A3 that has a 2.8 MW capacity. It is expected that the investment cost will be recovery in 16 years from cost savings. The 16,000 solar modules occupy 2.7 km and will provide electricity to nearly 600 houses . In Australia and some European countries, solar panels have a "dual use". Besides energy generation, the panels also act as sound barriers.

Figure II.40: Examples of Solar Panel (ROW/Vacant Land)

Figure II.41: Examples of Solar Panel (Building/Rest Area)

Value Extraction Application Framework

Examples: Wind Turbine (ROW and Vacant Land)

Go to Technical Memorandum

Although wind turbines along highway ROW are becoming increasingly common in Europe (e.g., Denmark, Germany, and the Netherlands), in the U.S. the value extraction application have not received great attention from the DOTs. One of the few examples can be found in the MassDOT (former Massachusetts Turnpike Authority), where a 400-foot-tall wind turbine with the potential to generate 1.5 MW has been considered to be installed in the middle of the 68-acre site, reaching around 1,500ft of set-back from the highway. This device is expected to generate 3,000 MWh of electricity per year, enough to supply the energy need of nearly 400 households. The land holding is adjacent to the Blandford service area.

The Ohio DOT (ODOT) is installing a small 32KW wind turbine at a maintenance facility in Northwood, adjacent to highway ROW along I-68. The wind turbine is approximately 100 feet tall and is located 140 feet from the roadway (i.e., setback). The wind system proposed is intended to help to provide up to 65% of the electricity consumed by the facility

TAK Studio envisioned light poles connected with wind turbines that would harvest the traffic turbulence and convert into electricity to supply the energy needed to illuminate the highways. The Israel National Roads Company is conducting the feasibility studies (i.e., front-end planning) to install small wind turbines tied in lighting poles along the coastal road, taking advantage of sea winds; and in Twain, where small wind turbines are being incorporated with parking lots.

The Colorado DOT (CDOT), Ohio DOT, MassDOT, and Illinois DOT that have worked with local consulting companies and/or universities to identify opportunity zones and sites suitable for renewable energy and revenue generating projects on highway ROW, rest areas, and weigh stations. The identification has been made by overlaying ROW maps and geographic information system (GIS) data layers of potential renewable energy source (i.e., solar, wind, geothermal, and biomass resource maps)

Figure II.42: Examples of Wind Turbine (ROW/Vacant Land)

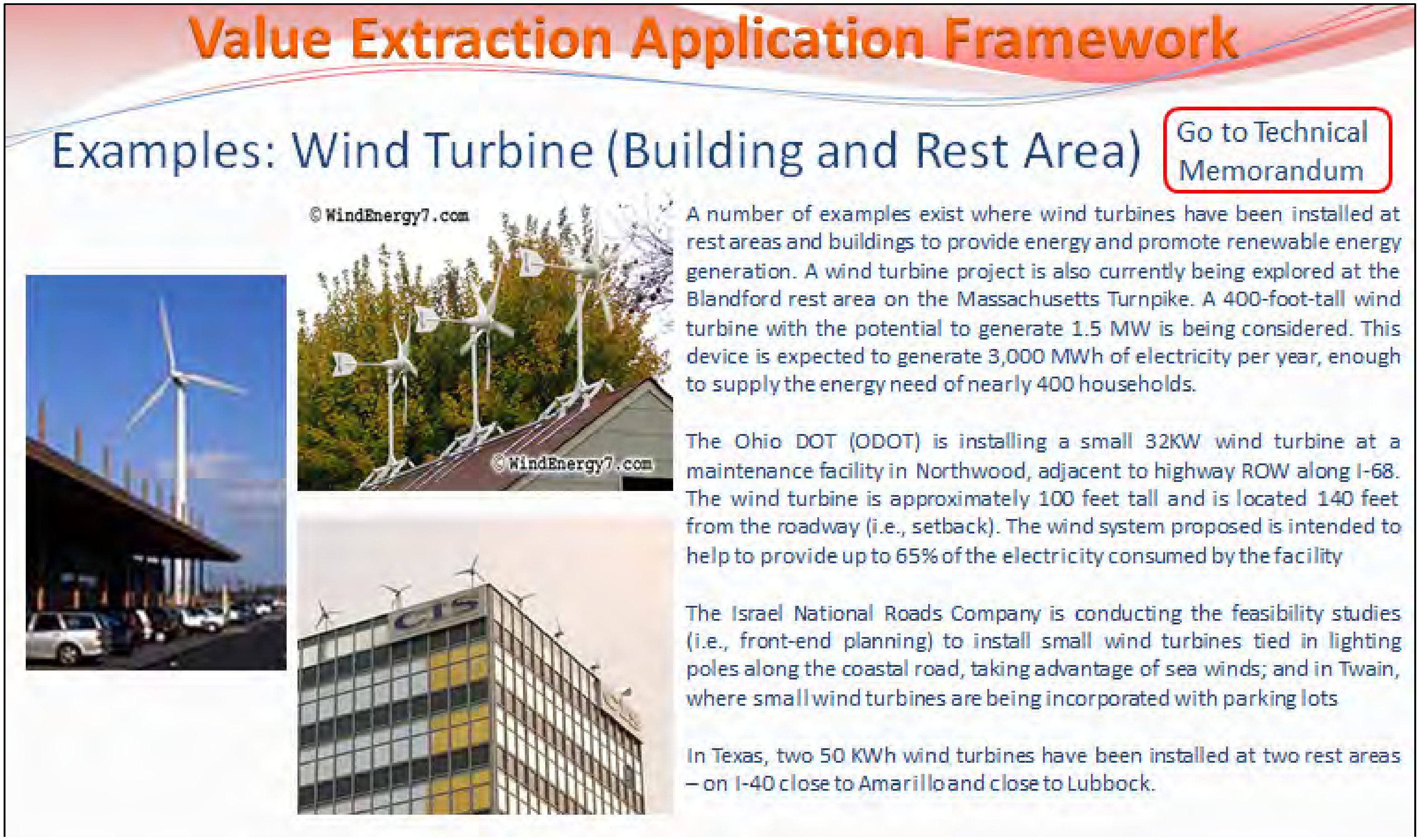
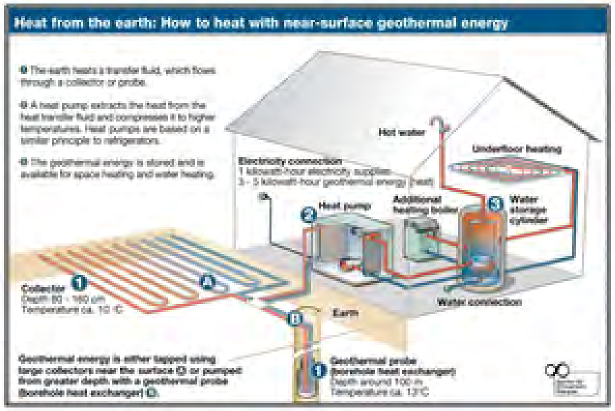


Figure II.43: Examples of Wind Turbine (Building/Rest Area)

Value Extraction Application Framework

Examples: Geothermal Energy

Go to Technical Memorandum



Geothermal heat pump is widely and commonly used in offices and residences to reduce energy consumption from HVAC systems. The size and complexity of GHP systems depends on the use of HVAC system and how much electricity is intended to be saved.

Geothermal systems – similar to GHP – have been applied as a de-icing mechanism on highways since late 40's. In this system, "heat pipes" are embedded in the pavement, where snow or ice layers have been constantly critical. According to up-to-date observations, it has been estimated that geothermal systems could keep the pavement free of snow and ice at temperature as low as -10ºF (-23ºC). Several DOTs have been adopted the geothermal system in very specific location, such as New Jersey, South Dakota, Wyoming, and Virginia, as well as countries such as, Japan, Switzerland, and Argentina

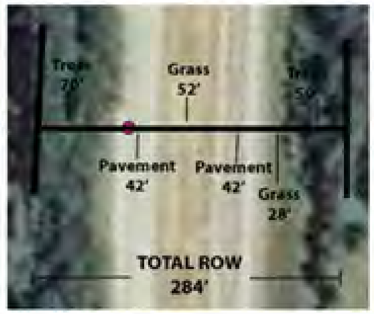
Ultimately, a broader approach has been undertaken by Colorado DOT (CDOT), Ohio DOT, MassDOT, and Illinois DOT that have worked with local consulting companies and/or universities to identify opportunity zones and sites suitable for renewable energy and revenue generating projects on highway ROW, rest areas, and weigh stations. The identification has been made by overlaying ROW maps and geographic information system (GIS) data layers of potential renewable energy source (i.e., solar, wind, geothermal, and biomass resource maps)

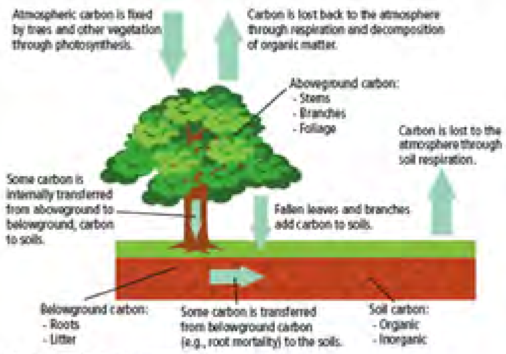
Figure II.44: Examples of Geothermal Energy

Value Extraction Application Framework

Examples: Carbon Sequestration

Go to Technical Memorandum





Source: U.S. Environmental Protection Agency

Carbon sequestration is the process of capturing and removing CO_2 and other forms of carbon from the atmosphere and, then, "storing" it in "reservoirs". A variety of techniques to sequester carbon exist, but the focus here is exclusively on vegetation management.

There is no formal carbon sequestration program in the U.S. besides the pilot programs and research studies conducted in states such as, New Mexico and Utah.

The Carbon Sequestration Pilot Program (CSPP), led by FHWA' Office of Natural and Human Environment (ONHE) and the New Mexico Department of Transportation (NWDOT), reported that in addition to improved vegetation management, carbon sequestration allows for: "(1) selling carbon credits on an appropriate GHG market or registry for revenue, (2) using carbon credits to offset the DOT's emissions, or (3) using the credits toward meeting statewide objectives."

Figure II.45: Examples of Carbon Sequestration

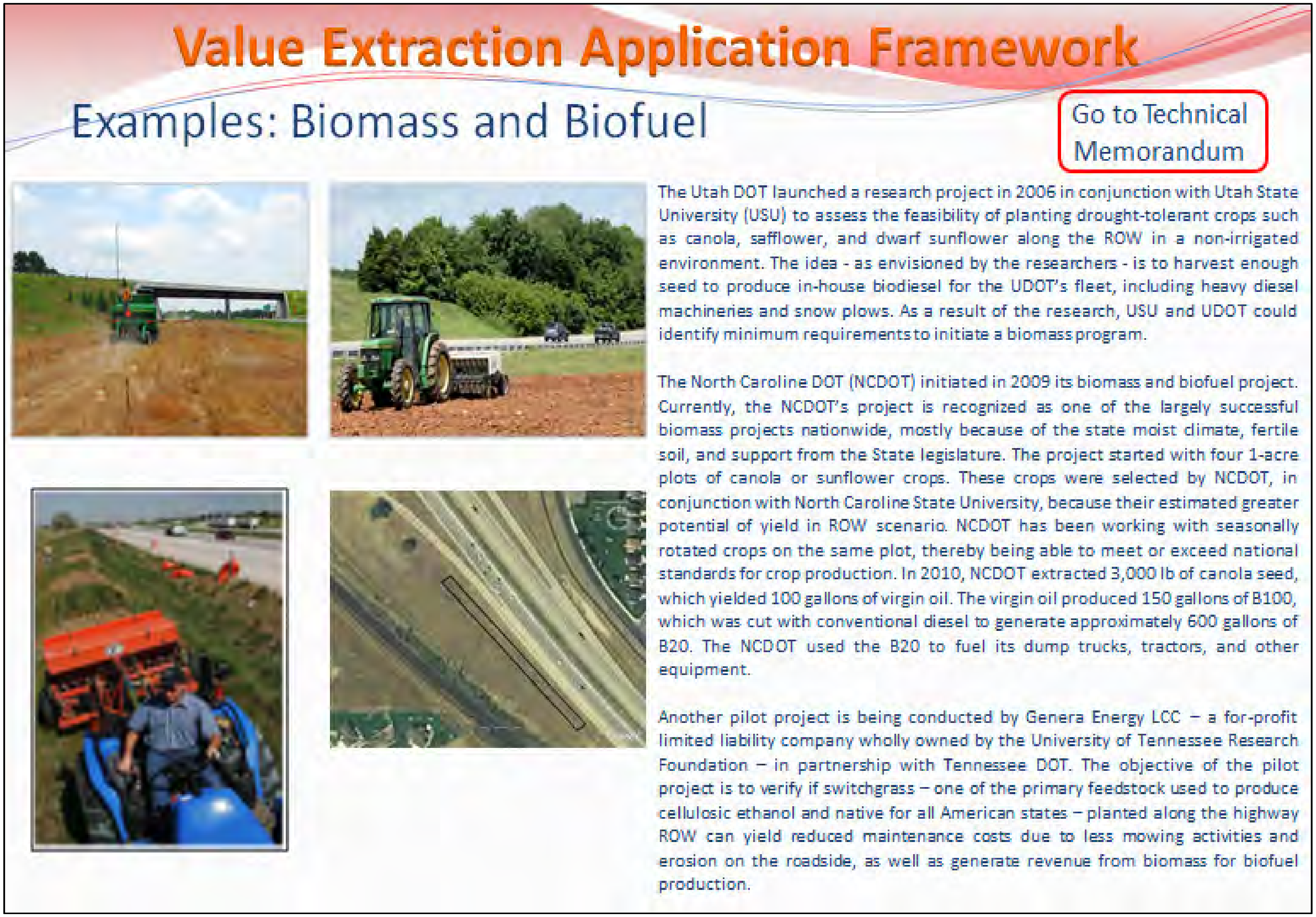
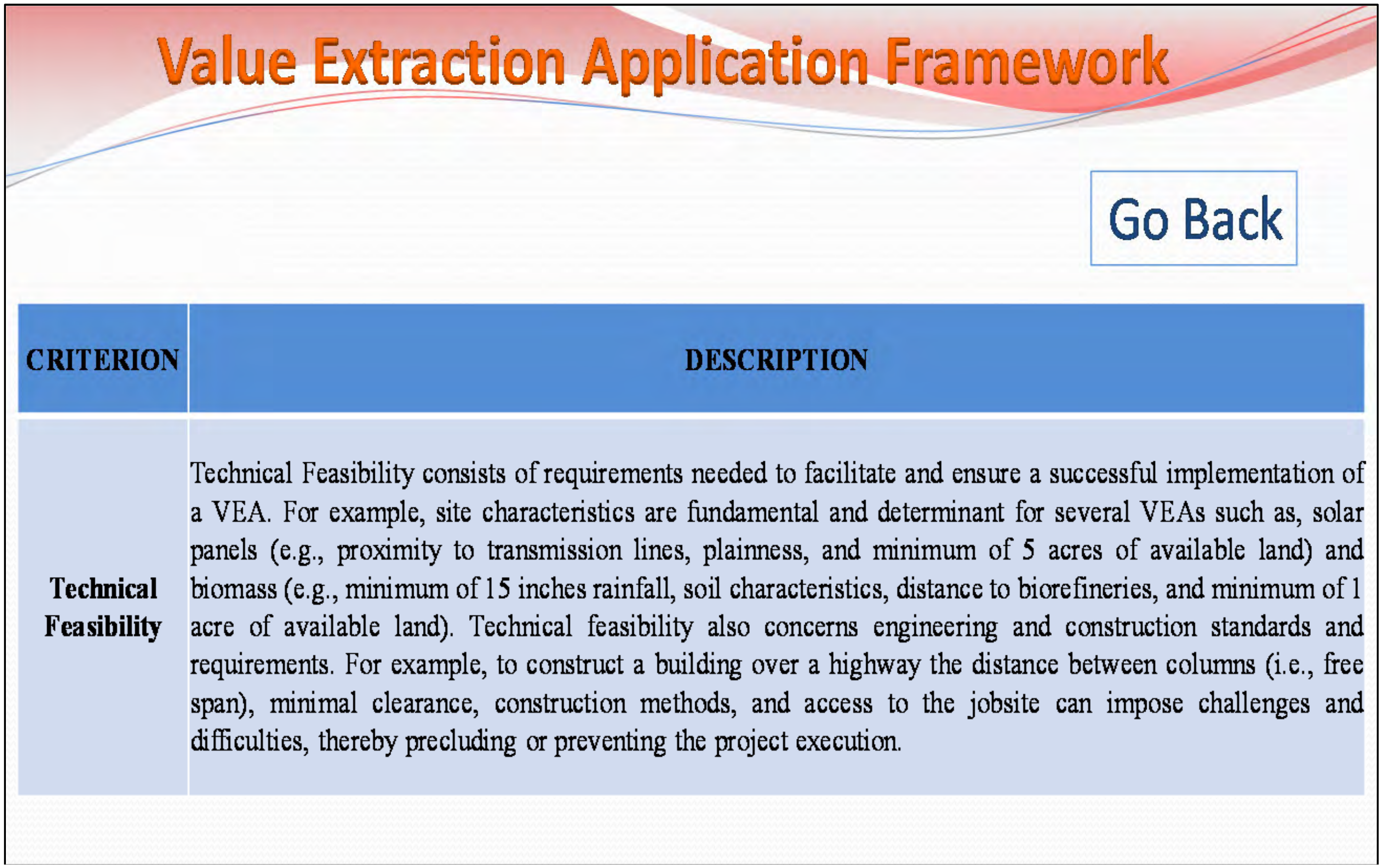


Figure II.46: Examples of Biomass & Biofuel

Figure II.47: Examples of Wildlife Crossing

Step 10: Definition of each criterion used in the evaluation matrix.



CRITERION	DESCRIPTION
Technical Feasibility	Technical Feasibility consists of requirements needed to facilitate and ensure a successful implementation of a VEA. For example, site characteristics are fundamental and determinant for several VEAs such as, solar panels (e.g., proximity to transmission lines, plainness, and minimum of 5 acres of available land) and biomass (e.g., minimum of 15 inches rainfall, soil characteristics, distance to biorefineries, and minimum of 1 acre of available land). Technical feasibility also concerns engineering and construction standards and requirements. For example, to construct a building over a highway the distance between columns (i.e., free span), minimal clearance, construction methods, and access to the jobsite can impose challenges and difficulties, thereby precluding or preventing the project execution.

Figure II.48: Definition of Technical Feasibility

Value Extraction Application Framework

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CRITERION	DESCRIPTION
Legal Considerations	Legal Considerations comprise, among others, Federal and State legislation, the FHWA policies and regulations, the National Environmental Policy Act (NEPA) and other environmental regulations, the Federal Aviation Association (FAA) regulations, and the AASHTO policies, which can directly or indirectly affect and/or drive the implementation of a potential VEA. Legal Considerations also concern studies and analysis that must be conducted, as well as permits and licenses that must be obtained. Finally, Legal Considerations include written agreements, liabilities, business models, and responsibilities. For example, Federal and State regulations govern the types of activities that can and cannot occur on ROW held by DOTs, or purchased by the DOTs. 23 Code of Federal Regulations (CFR) Chapter 1, for the most part, is the main source of regulation regarding the activities and opportunities that DOTs are granted vis-à-vis the federal system of interstate highways. Moreover, Federal law currently prohibits DOTs from privatizing and commercializing rest areas along the interstate highways. In Texas, Texas Transportation Code and Texas Administrative Code govern the activities and opportunities surrounding TxDOT's ROW and real estate. Furthermore, Transportation Code Sub-chapter C of Chapter 202 governs leases, easements, and agreements that concern highway property. Section 202.052 allows the department to lease a highway asset, part of the ROW, or airspace above or underground a highway, if the department determines that the interest to be leased will not be needed for a highway purpose during the term of the lease. Also in Texas, "TxDOT regulates the display of off-premise outdoor advertising signs along highways regulated by the Highway Beautification Act (HBA) and all other highways and roads located outside of the corporate limits of cities, towns and villages in Texas under the State Rural Roads Act (RRA)". In some cases, the lack of zoning law can defer or even impair the implementation of projects such as, solar, wind, and geothermal. As said, environmental analysis is also a requirement for any project on public land. A project must be in compliance with NEPA – either FHWA or DOE process, if not both – to receive an environmental permit. Finally, for any construction over 200ft, the form "74601-Notice of Proposed Construction or Alteration" must be filed with the Federal Aviation Administration (FAA) prior its outset. The FAA and the Department of Defense (DOD) will review the form and issue a permit.

Figure II.49: Definition of Legal Considerations

Value Extraction Application Framework

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CRITERION	DESCRIPTION
Financial / Economic Feasibility	The implementation of any VEA requires somewhat an upfront investment by TxDOT or private investors. The Financial/Economic Feasibility addresses the order of magnitude of the upfront investment and its consequential payback period, as well as indirect economic benefits that the implementation of a VEA can bring to TxDOT and society. For example, wildlife crossing projects will typically cost $1 to $3 million to TxDOT and will be paid off through cost savings from removing animal carcass and vehicle wrecks caused by animal-vehicle-crash incidents (AVC). Wildlife crossing can also economically benefit the society by preventing human fatalities from AVC (i.e., value of human life), reducing vehicle insurance costs, and creating temporary jobs (i.e., construction jobs). Another example is property management, which can generate revenue to TxDOT (e.g., selling or leasing land lots or properties) and/or saving costs (e.g., swap transaction with construction of a new facility). Furthermore, property management can also help to economically develop areas (i.e., creation of business opportunities and jobs on urban areas) and raise taxes payments for the state (i.e., payment of land taxes by private owners).

Figure II.50: Definition of Financial/Economic Feasibility

Value Extraction Application Framework

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CRITERION	DESCRIPTION
Political/Public Concerns	Political and Public Concerns refer to how the VEA will likely be seen and accepted by the general public and politicians. In other words, Political and Public Concerns look at whether the VEA is controversial, potential impacts on nearby communities and businesses, likelihood of sparking public outcry and opposition, and impacts on TxDOT image. For example, selling or leasing vacant land to new business development can negatively impact on neighbors (e.g., increase traffic congestion and decrease property value) and existing businesses (e.g., concurrence), therefore causing public dissatisfaction. Some VEA can, on the other hand, enhance TxDOT image and bring support from nearby communities, as well as local politicians. These positive results mostly occur when the VEA involves public goodwill and/or social benefits without entailing increase of tax payment. For example, wildlife crossing can integrate habitats, protect endangered species, enhance road safety, create jobs, and, even, reduce car insurance costs. Another example is parking lot that can alleviate traffic congestion, stimulate business development, and raise some funds for the department.

Figure II.51: Definition of Political/Public Concerns

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CRITERION	DESCRIPTION
Environmental Considerations	Highway projects is well-known from and continuously criticized because the environmental impacts provoked by them such as, habitat fragmentation, deforestation, noise and dust during and after construction, vehicular emissions (i.e., GHG), and threats on endangered species (i.e., animal-vehicle-crash). Environmental Considerations take into account the contribution a VEA can have to enhance and preserve the environment or, otherwise, harm and threaten the natural habitat. Wind turbine, for example, is a renewable and non-pollutant energy source. Wind turbine can thus contribute to reduce GHG emission from power generation and help to combat the global warming. On the other hand, wind turbine can be detrimental to nearby communities – because of noise and shade – and danger for birds and bats.

Figure II.52: Definition of Environmental Considerations

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CRITERION	DESCRIPTION
Safety Considerations	TxDOT's primary mission is to provide safe vehicle transportation routes with adequate capacity. Safety Considerations are thus crucial criterion and concern any potential impact that implementing a VEA can provoke on the safety of road users and general public. Basically, safety considerations look at clear zones, obstacles and obstruction created, accesses needed, risks imposed during implementation or maintenance of the VEA project, and likelihood of provoking accidents. Rest areas, for example, are essential to road safety. Privatizing and/or offering better service at rest areas can stimulate drivers to stop by, avoid rest areas' closure, and, even, increase the availability of rest stops. Consequently, road accidents caused by "drowsy driving" - a serious problem that leads to thousands of automobile crashes each year – can be reduced and, consequently, the road safety enhanced. Another good example is wildlife crossing. Several studies have demonstrated that a well-designed wildlife crossing can effectively enhance the roadway safety and diminish the occurrence of animal-vehicle accidents. On the other hand, safety concerns may arise whenever a wildlife crossing project is planned to be built on existing roads. Safety is also a major concern when using advertising in highway ROW. FHWA and AAA Foundation for Traffic Safety argue that advertising can distract drivers, thereby causing accidents. Furthermore, signs and billboards must be located outside the safety zone to protect drivers that run off the road.

Figure II.53: Definition of Safety Considerations

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CRITERION	DESCRIPTION
Potential Social Impacts / Benefits	Essentially, Social Impacts and/or Benefits concern how a VEA can impact on business opportunities, economic development, job creation, and general welfare. For example, facilitating the implementation of telecommunication tower in rural areas can enhance internet and cell-phone signals. Nowadays, these infrastructures are essential for economic development. Moreover, internet plays important role on education and professional development. On the other hand, privatizing rest areas may entail unfair competition with local business in small communities, hence negatively impacting on the social welfare. On the other hand, well served and interactive rest areas and welcome centers can potentially enhance the tourism market and create jobs, therefore helping to develop rural areas. Another example is renewable energy projects (i.e., solar, wind, geothermal, and biomass energy). Because of the scalability (i.e., capability of being implemented with different sizes and capacities), renewable energy project can be decentralized and deployed close to end-users. Not only can these proprieties reduce the cost of transmission lines, but they can be fundamental to enable electricity supply in remote and rural areas, thereby promoting economic development, jobs, and welfare. However, depending on location of the project, renewable systems can impact on nearby communities (e.g., noise, shade, and property value reduction).

Figure II.54: Definition of Potential Social Impacts/Benefits

Step 11: Assign weights according to relative importance of each criterion.

Value Extraction Application Framework

Criteria Weight & Score Scale

	Weight Scale		
Feasibility	**Technical**	0.23	**5**
	Legal	0.45	**10**
	Economical	0.32	**7**
Impact	**Political/Public**	0.21	**6**
	Environmental	0.24	**7**
	Safety	0.34	**10**
	Social	0.21	**6**

Score Scale		
Negative Impact	-2	**Major Concerns**
	-1.5	
Somewhat Negative	-1	**Minor Concerns**
	-0.5	
Neutral	0	**Neutral**
	0.5	
Somewhat Positive	1	**Minor Benefits**
	1.5	
Positive Impact	2	**Major Benefits**

Weight Scale:
10 = Very Important
1 = Insignificant or Indifferent

Figure II.55: Input of Criteria Weight and Display of Score Scale

Step 12: Analyze each VEA using the evaluation matrix.

Table II.1: Property Management Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
1	Trained in-house staff in ROW and Real Estate management.								
2	In-house staff member to champion the evaluation and implementation of a property management application.								
3	Ease of integrating property management application in TxDOT's organizational and decision-making structure.								
4	Availability of resources to update databases and/or GIS inventory								
5	In-house resource to systematically review and assess current asset and future asset needs.								
6	Willingness to invest in resources such as information system, website, and GIS system.								
7	Access to TxDOT's property inventory to determine characteristics/features of property assets (e.g., size, location, value, maintenance cost, and overall condition).								
8	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
9	Current value (i.e., market/Real Estate value) of the property.								
10	Current maintenance expenses on the property asset and potential savings if disposing of the property.								
11	Formal procedures/guidelines available to conduct/implement TxDOT property management program.								
12	Anticipated impacts on nearby community of "new" property use (i.e., new owner or lessee), including potential to mitigate anticipated impacts.								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
13	Anticipated environmental impacts and mitigation measurements of "new" property use.								
14	Permit or license required for "new" property use.								
15	Financial resources of and warranties (i.e., bond approval and surety) provided by the developer interested in buying/leasing/swapping property.								
16	Anticipated direct and indirect jobs created and economic development impacts resulting from "new" use of property.								
17	Anticipated benefits to TxDOT (e.g., financial, technical, and safety) of disposing of "obsolete" assets.								
18	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).								
19	Potential conflict with zoning law, city's master plan, and transportation's plan.								
20	Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" use).								
21	Legal constraints/issues that can jeopardize the transaction.								
22	Available legal consultants/resources to implement TxDOT property management program.								
23	Available legal consultants/resources to advise and review transactions and contractual agreements.								
24	Resources required to train or acquire in-house legal resources/counsel.								
25	TxDOT's exposure in terms of liability and risks.								
26	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.2: Property Management (Rest Area) Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house staff in ROW and Real Estate management.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	If retrofitting rest areas, available in-house staff to specify and oversee design and construction (retrofit) of rest area.								
4	Available data on number of vehicles passing by (and visiting) the rest area.								
5	If considering privatization or a private partnership investor/developer(s) interested in managing/operating rest area.								
6	Access to TxDOT rest area inventory to determine characteristics/features (e.g., size, location, value, maintenance cost, and overall condition) of rest area.								
7	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
8	Current value (i.e., market/Real Estate value) of the property.(i.e., rest area).								
9	Current maintenance expenses on the rest area and potential savings from implementing the VEA.								
10	Formal procedures/guidelines available to TxDOT to implement public-private partnership agreements and or privatize rest areas.								
11	Anticipated impacts of privatizing the rest area on nearby community (i.e., economic and social impacts), including potential to mitigate anticipated impacts.								
12	Anticipated environmental impacts and mitigation measures.								
13	Permit(s) or license(s) required.								
14	Financial resources of and warranties (i.e., bond								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	approval and surety) provided by the developer interested in leasing or partnering with TxDOT.								
15	Anticipated direct and indirect jobs created and economic development impacts.								
16	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
17	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								
18	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).								
19	Potential conflict with zoning law, city's master plan, and transportation's plan.								
20	Anticipated political and public opposition to project (e.g., controversy and potential impacts triggered by rest area privatization).								
21	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).								
22	Legal constraints and barriers that can impede/preclude the project (e.g., rest area privatization).								
23	Resources required to train and acquire in-house legal resources/counsel.								
24	Available legal consultants/resources to advise and review transactions and contractual agreements.								
25	TxDOT's exposure in terms of liability and risks.								
26	Compliance with Interstate Oasis Program, FHWA, AASTHO, and other's agency requirements and policies.								
27	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.3: Airspace Leasing (Building) Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	Staff to specify and oversee design and construction of the project.								
3	In-house staff member to champion the evaluation and implementation of the VEA.								
4	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.								
5	Project characteristics (e.g., footprint) and potential impacts on traffic, utilities, community, and environment (e.g., congestion, aesthetics, privacy, shade, and property value) that could impact project/application feasibility.								
6	Site characteristics (i.e., location, logistics, access, environment, and infrastructure) that could impact project/application feasibility.								
7	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
8	Current value (i.e., market/Real Estate value) of the property.in the area.								
9	Formal procedures/guidelines available to conduct/implement an airspace leasing program (i.e., agreement, design, construction, and maintenance).								
10	The project is designed and implemented as a component/together with a new highway project (i.e., already included in the highway design).								
11	Anticipated impacts of the project (i.e., "new owner or lessee") on nearby community (e.g., traffic congestion, shade, privacy, noise, and								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
	property values, including potential to mitigate anticipated impacts.								
12	Anticipated environmental impacts and mitigation measure for "new" property use/project.								
13	Construction plan includes measures to avoid/reduce traffic congestion, dust, noise, unsafe situations, accidents, and other negative community impacts.								
14	Traffic control plan during construction and anticipated safety training required.								
15	Building and tunnel comply with all safety requirements (e.g., lighting, exhaustion, ventilation, drainage, access, and fire protection).								
16	Compliance with FHWA, AASTHO, and other agency requirements.								
17	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.								
18	Permit or license required to execute/construct project.								
19	Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.								
20	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								
21	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
22	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								
23	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).								
24	Potential conflict with zoning law, city's master plan, and transportation's plan.								
25	Anticipated political and public opposition to								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	transaction (e.g., controversy and potential impacts triggered by the "new" project).								
26	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).								
27	Legal constraints/concerns that can impede or prevent the transaction/project.								
28	Available legal consultants/resources to implement TxDOT's airspace leasing program.								
29	Available legal consultants/resources to advise and review transactions and contractual agreements.								
30	Resources required to train or acquire in-house legal resources/counsel.								
31	TxDOT's exposure in terms of liability and risks.								
32	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.4: Airspace Leasing (Parking lot) Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.								
4	Current demand/need for additional parking space in the area.								
5	Project characteristics and potential impacts on traffic, utilities, community, and environment (e.g., drainage and runoff) that could impact project/application feasibility.								
6	Site characteristics (i.e., location, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.								
7	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
8	Current value (i.e., market/Real Estate value) of the property.								
9	Formal procedures/guidelines available to conduct/implement an airspace leasing program (i.e., agreement, design, construction, and maintenance).								
10	The parking lot is designed and implemented as a component/together with a new highway project (i.e., already included in the highway design).								
11	Anticipated traffic impacts of the new parking lot.								
12	Anticipated environmental impacts and mitigation measure for parking lot project.								
13	Construction plan includes measures to								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	avoid/reduce traffic congestion, dust, noise, unsafe situations, accidents, and other negative community impacts.								
14	Required investments in technologies and systems (e.g., parking meters and surveillance systems).								
15	Compliance with FHWA, AASTHO, and other agency requirements.								
16	Parking lot design complies with safety requirements (e.g., curbs, fences, lighting, access, fire protection, pedestrian access, and surveillance).								
17	Permit or license required to execute/construct project.								
18	Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.								
19	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								
20	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
21	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								
22	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).								
23	Potential conflict with zoning law, city's master plan, and transportation's plan.								
24	Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).								
25	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).								
26	Legal constraints/concerns that can impede or prevent the transaction/project.								

#	Statement	**Feasibility**				**Impact**			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
27	Available legal consultants/resources to implement TxDOT's airspace leasing program.								
28	Available legal consultants/resources to advise and review transactions and contractual agreements.								
29	Resources required to train or acquire in-house legal resources/counsel.								
30	TxDOT's exposure in terms of liability and risks.								
31	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.5: Airspace Leasing (Utility) Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.								
4	Interested parties (i.e., potential developers) have been identified or have approached TxDOT.								
5	Utility is considered private (i.e., will require airspace leasing agreement).								
6	Project characteristics and potential impacts on traffic, utilities, community, and environment (e.g., water or soil contamination, explosive, and safety concerns) that could impact project/application feasibility.								
7	Site characteristics (i.e., location, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.								
8	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.								
9	Current TxDOT demand/need for utility (e.g., electricity required to power Dynamic Message Signs and/or need for telecommunication signal (e.g., cell phone and internet, or for transmission of data).								
10	Potential for competing with private sector (e.g., existing private tower near TxDOT property considered for airspace leasing).								
11	The utility is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
12	Ability to appropriately divulgate, involve, and communicate the project to general public and stakeholders (i.e., transparency and equal opportunity).								
13	Current value (i.e., market/Real Estate value) of the property								
14	Formal procedures/guidelines available to conduct/implement an airspace leasing program (i.e., agreement, design, construction, and maintenance).								
15	Potential impacts on road maintenance plan and operations (e.g., utilities crossing the road, antenna installation, and utility maintenance).								
16	Anticipated environmental impacts and mitigation measures..								
17	Potential risk of accidents/unsafe situations (e.g., explosion precaution, electrical discharge/shock, leak detection, valves, clear zone, and accidents).								
18	Construction plan includes measures to avoid/reduce traffic congestion, noise, unsafe situations, accidents, and other negative community impacts.								
19	Required investments in technologies and systems.								
20	Compliance with FHWA, AASTHO, and other agency requirements.								
21	Permit or license required to execute/construct project.								
22	FAA and DOD approved and granted permit for the project (i.e., if the project is located within 3-5 miles from a public or military airport, or has tower higher than 200 ft).								
23	Financial resources of and warranties (i.e., bond approval and surety) provided the project developer.								
24	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								

#	Statement	**Feasibility**				**Impact**			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
25	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
26	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								
27	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).								
28	Potential conflict with zoning law, city's master plan, and transportation's plan.								
29	Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).								
30	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).								
31	Legal constraints/concerns that can impede or prevent the transaction/project.								
32	Available legal consultants/resources to implement TxDOT's airspace leasing program.								
33	Available legal consultants/resources to advise and review transactions and contractual agreements								
34	Resources required to train or acquire in-house legal resources/counsel								
35	TxDOT's exposure in terms of liability and risks (e.g., utility relocation).								
36	Investment required by TxDOT to implement the VEA								
Total contribution of the criterion									

Table II.6: Advertising Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Interested parties have been identified or have approached TxDOT.								
4	Available data/information on traffic exposure (i.e., visibility).								
5	Identified and selected advertising mode (e.g., brochures, outdoor advertising, blue signs, live vegetation, or naming rights).								
6	Project characteristics and potential impacts on traffic, road maintenance, utilities, nearby communities, and the environment.								
7	Site characteristics (i.e., location, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.								
8	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.								
9	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
10	Current value (i.e., market/Real Estate value) of the property.								
11	Formal procedures/guidelines available to conduct/implement advertising program (e.g., staff, specifications, and agreements).								
12	Anticipated environmental impacts and mitigation measures..								
13	Potential risk of accidents/unsafe situations (e.g., crash, clear zones, and driver distraction).								
14	Potential educational benefits associated with								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
	advertising content (i.e., message and images).	■		■			■		
15	Required investments in technologies and systems (e.g., electricity, internet, and fiber optics).		■			■	■	■	■
16	Compliance with FHWA, AASTHO, TxDOT State Rural Act, and other agencies' requirements					■	■		■
17	Permit or license required to execute/construct project.	■				■	■	■	■
18	Compliance with Texas Highway Beautification Act (HBA).	■		■			■	■	■
19	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.	■	■				■	■	
20	Anticipated benefits to the region or state (e.g., increase local or state taxes).	■	■				■	■	
21	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).		■			■	■		■
22	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).	■		■			■	■	■
23	Potential conflict with zoning law, city's master plan, and transportation's plan.	■		■			■	■	
24	Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).	■	■	■			■	■	■
25	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).	■					■	■	■
26	Legal constraints/concerns that can impede or prevent the transaction/project	■		■		■	■	■	■
27	Available legal consultants/resources to implement TxDOT's advertising program.	■				■	■	■	■
28	Available legal consultants/resources to advise and review transactions and contractual agreements.	■				■	■	■	■
29	Resources required to train or acquire in-house legal resources/counsel.	■	■				■	■	■
30	TxDOT's exposure in terms of liability and risks.	■					■	■	■

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
31	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.7: Solar Panels (ROW and Vacant Land) Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.		■			■	■	■	■
2	In-house staff member to champion the evaluation and implementation of the VEA.		■			■	■	■	■
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.		■			■	■		■
4	Interested parties (i.e., potential developers) have been identified or have approached TxDOT.		■			■	■	■	■
5	Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.	■						■	■
6	Project characteristics and potential impacts on traffic (e.g., driver distraction), community (e.g., property values), and the environment.		■	■					
7	Site characteristics (i.e., location, solar potential, clearances, access, and infrastructure)		■			■			■
8	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.					■	■	■	
9	The solar project is designed and implemented as a component together with a new highway project (i.e., already included in the highway design)..		■			■	■	■	■
10	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).		■	■			■	■	■
11	Access to vendors/solar specialists (e.g., for installation and maintenance).		■				■	■	
12	Current TxDOT demand/need for electricity at the project site (e.g., lighting pole and signs).		■			■	■	■	■
13	Ability/cost to connect to the grid (e.g., distance from transmission lines).		■			■	■	■	■

#	Statement	**Feasibility**				**Impact**			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
14	Need for backup system for solar project (i.e., battery or on-grid electricity source) to supply TxDOT's electricity needs.								
15	Available infrastructure (e.g., fiber optic or wireless signal) at site to support and facilitate monitoring and management of the project/output.								
16	Current value (i.e., market/Real Estate value) of the property.								
17	Formal procedures/guidelines available to conduct/implement solar energy project (i.e., agreement, design, construction, and maintenance).								
18	Potential impacts of the solar project on road maintenance and operations (e.g., impact of solar panel maintenance).								
19	Anticipated environmental impacts and mitigation measures.								
20	Potential risk of accidents/unsafe situations (e.g., accidents, driver distraction, clear zones, guard rails, and adequate access to site).								
21	Compliance with Texas Highway Beautification Act (HBA).								
22	Construction plan includes measures to avoid/reduce traffic congestion, noise, unsafe situations, accidents, and other negative community impacts.								
23	Required investments in technologies and systems.								
24	Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.								
25	Permit or license required to execute/construct project.								
26	FAA has approved and granted permit for the solar project (i.e., if the project is located within 3-5 miles from a public or military airport).								
27	Net metering applies.								

#	Statement	**Feasibility**				**Impact**			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
28	Federal and State incentives, as well as Renewable Energy Credits (REC) are available.								
29	Potential concerns about "free access" to TxDOT's property (i.e., facility, land, or ROW) by third party.								
30	Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.								
31	Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).								
32	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								
33	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
34	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								
35	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).								
36	Potential conflict with zoning law, city's master plan, and transportation's plan.								
37	Anticipated political and public opposition to transaction/project (e.g., controversy and potential impacts triggered by the "new" project)								
38	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.								
39	Legal constraints/concerns that can impede or prevent the transaction/project.								
40	Patents and associated costs that could impact project/application feasibility.								
41	Available legal consultants/resources to								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
	implement TxDOT's solar program.								
42	Available legal consultants/resources to advise and review transactions and contractual agreements.								
43	Resources required to train or acquire in-house legal resources/counsel.								
44	TxDOT's exposure in terms of liability and risks (e.g., solar array relocation or damage).								
45	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.8: Solar Panels (office & facility) Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement								
4	Interested parties (i.e., potential developers) have been identified or approached TxDOT.								
5	Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.								
6	Site/building characteristics (i.e., location, solar potential, access, and infrastructure) that could impact project/application feasibility.								
7	Building/facility's electrical system has been/can be retrofitted to use solar energy.								
8	The roof area/external area is large enough to generate sufficient energy to meet the building/facility's energy demand.								
9	The solar project is financially feasible.								
10	The solar project is designed and implemented as a component of building/facility (i.e., included in the building/facility design).								
11	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
12	Access to vendors/ solar panel specialists (e.g., for installation and maintenance).								
13	Current TxDOT demand/need for electricity at the site (e.g., building/facility electricity usage).								
14	Ability/cost to connect to the grid (e.g., distance								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
	from transmission lines).								
15	Need for backup system for solar project (i.e., battery or on-grid electricity source) to supply TxDOT's electricity needs.								
16	Formal procedures/guidelines available to conduct/implement solar energy project (i.e., agreement, design, construction, and maintenance).								
17	Anticipated environmental impacts and mitigation measures.								
18	Potential risk of accidents/unsafe situations.								
19	Required investments in technologies and systems.								
20	Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.								
21	Permit or license required to execute/construct project.								
22	FAA has approved and granted permit for the solar project (i.e., if the project is located within 3-5 miles from a public or military airport).								
23	Net metering applies.								
24	Federal and State incentives, as well as Renewable Energy Credits (REC) are available.								
25	Potential concerns about "free access" to TxDOT's property (i.e., facility or building) by third party.								
26	Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.								
27	Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).								
28	Anticipated benefits to TxDOT (e.g., financial, technical, and social).								
29	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g.,								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
	FHWA, DOE, and DOD).								
30	Anticipated political and public opposition to solar project (e.g., controversy and potential impacts triggered by the "new" project).								
31	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.								
32	Legal constraints/concerns that can impede or prevent the transaction/project.								
33	Available legal consultants/resources to implement TxDOT solar program.								
34	Available legal consultants/resources to advise and review transactions and contractual agreements.								
35	Resources required to train or acquire in-house legal resources/counsel.								
36	TxDOT's exposure in terms of liability and risks (e.g., solar array relocation or damage).								
37	Investment required by TxDOT to implement the VEA.								
Total Contribution of the criterion									

Table II.9: Wind Turbine Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.								
4	Interested parties (i.e., potential developers) have been identified or have approached TxDOT.								
5	Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.								
6	Project characteristics and potential impacts on traffic (e.g., driver distraction) and nearby community (e.g., property value, noise, shade, and tourism).								
7	Site characteristics (i.e., location, wind potential, clearances, access, and infrastructure)								
8	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.								
9	The wind project is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).								
10	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
11	Access to vendors/ wind turbine specialists (e.g., for installation and maintenance).								
12	Current TxDOT demand/need for electricity at the project site (e.g., lighting pole and signs).								
13	Ability/cost to connect to the grid (e.g., distance								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	from transmission lines).								
14	Need for backup system for wind project (i.e., battery or on-grid electricity source) to supply TxDOT's electricity needs.								
15	Available infrastructure (e.g., fiber optic or wireless signal) at site to support and facilitate monitoring and management of the wind energy project/output.								
16	Current value (i.e., market/Real Estate value) of the property.								
17	Formal procedures/guidelines available to conduct/implement wind energy project (i.e., agreement, design, construction, and maintenance).								
18	Potential impacts of the wind project on road maintenance and operations (e.g., impact of wind turbine installation and maintenance)								
19	Anticipated environmental impacts and mitigation measures.								
20	Potential risk of accidents/unsafe situations (e.g., accidents, blade failure, fire, blade flickering, oil leaks, snow throw, driver distraction, clear zone, guard rails, and adequate access to site).								
21	Compliance with Texas Highway Beautification Act (HBA).								
22	Construction plan includes measures to avoid/reduce traffic congestion, noise, unsafe situations, accidents, and other negative community impacts.								
23	Required investments in technologies and systems.								
24	Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.								
25	Permit or license required to execute/construct project.								
26	Potential interference with nearby								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	telecommunication, radar, and/or wireless signals.								
27	FAA and DOD approved and granted permit for the project (i.e., if the project is located within 3-5 miles from a public or military airport, or the wind turbine is higher than 200 ft).								
28	Net metering applies.								
29	Federal and State incentives, as well as Renewable Energy Credits (REC) are available.								
30	Potential concerns about "free access" to TxDOT's property (i.e., land or ROW) by third party.								
31	Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.								
32	Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).								
33	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								
34	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
35	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								
36	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).								
37	Potential conflict with zoning law, city's master plan, and transportation's plan.								
38	Anticipated political and public opposition to wind energy project (e.g., controversy and potential impacts triggered by the "new" project).								
39	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
40	Legal constraints/concerns that can impede or prevent the transaction/project.								
41	Patents and associated costs that could impact project/application feasibility.								
42	Available legal consultants/resources to implement TxDOT wind program.								
43	Available legal consultants/resources to advise and review transactions and contractual agreements.								
44	Resources required to train or acquire in-house legal resources/counsel.								
45	TxDOT's exposure in terms of liability and risks (e.g., wind turbine relocation or damage).								
46	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.10: Wind Turbine (Office & Facility) Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.								
4	Interested parties (i.e., potential developers) have been identified or approached TxDOT.								
5	Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.								
6	Project characteristics and potential impacts on traffic (e.g., driver distraction) and nearby community (e.g., property value, noise, shade, and tourism) that could impact project/application feasibility.								
7	Site/building characteristics for implementation of the wind system project (i.e., location, wind potential, access, and infrastructure) that could impact project/application feasibility.								
8	Building/facility's electrical system has been/can be retrofitted to use wind system.								
9	The roof area/external area is large enough to generate sufficient energy to meet the building/facility's energy demand.								
10	The wind project is financially feasible.								
11	The wind project is designed and implemented as a component of building/facility (i.e., included in the building/facility design).								
12	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
	equal access to information).								
13	Access to vendors/ wind turbine specialists (e.g., for installation and maintenance).								
14	Current TxDOT demand/need for electricity at the site (e.g., building/facility electricity usage).								
15	Ability/cost to connect to the grid (e.g., distance from transmission lines).								
16	Need for backup system for wind project (i.e., battery or on-grid electricity source) to supply TxDOT's electricity needs.								
17	Formal procedures/guidelines available to conduct/implement wind energy project (i.e., agreement, design, construction, and maintenance).								
18	Anticipated environmental impacts and mitigation measures.								
19	Potential risk of accidents/unsafe situations (e.g., accident, electrical shock, blade failure, fire, blade flickering, oil leak, and snow throw).								
20	Required investments in technologies and systems.								
21	Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.								
22	Permit or license required to execute/construct project.								
23	Potential interference with nearby telecommunication, radar, and/or wireless signal.								
24	FAA and DOD approved and granted permit for the project (i.e., if the project is located within 3-5 miles from a public or military airport, or the wind turbine is higher than 200 ft).								
25	Net metering applies.								
26	Federal and State incentives, as well as Renewable Energy Credits (REC) are available.								
27	Potential concerns about "free access" to TxDOT's property (i.e., office and facility) by third party.								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
28	Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.								
29	Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).								
30	Anticipated benefits to TxDOT (e.g., financial, technical, and social).								
31	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).								
32	Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).								
33	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.								
34	Legal constraints/concerns that can impede or prevent the transaction/project.								
35	Available legal consultants/resources to implement TxDOT wind program.								
36	Available legal consultants/resources to advise and review transactions and contractual agreements.								
37	Resources required to train or acquire in-house legal resources/counsel.								
38	TxDOT's exposure in terms of liability and risks (e.g., wind turbine relocation or damage).								
39	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.11: Geothermal Energy Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement								
4	Interested parties (i.e., potential developers) have been identified or have approached TxDOT.								
5	Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.								
6	Project characteristics and potential impacts on traffic (e.g., driver distraction) and nearby community (e.g., property value, noise, steam, water disposal, and aquifer).								
7	Site characteristics (i.e., location, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.								
8	Quality of the underground resource (i.e., temperature, depth, water, ease to drill) is coherent with the intended application (i.e., direct use of hot water, geothermal heat pump, pavement de-icing, and electricity generation).								
9	The roof and/or external area is large enough to install the geothermal energy system (i.e., power plant and/or geothermal heat pump) demanded in the building/facility or to generate sufficient energy to the building/facility's energy demand.								
10	The geothermal project is financially feasible.								
11	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
12	The geothermal energy is designed and implemented as a component together with a new highway or building project (i.e., already included in the highway or building design).								
13	Building/facility's electrical and/or HVAC systems have been/can be retrofitted to use geothermal energy (i.e., power plant and/or geothermal heat pump).								
14	Ability to communicate, involve, and share information about the project/application with general public and stakeholders (i.e., transparency and equal opportunity).								
15	Access to vendors/ geothermal energy specialists (e.g., for installation and maintenance).								
16	Current TxDOT demand/need for electricity at the project site (e.g., lighting pole and signs).								
17	Ability/cost to connect to the grid (e.g., distance from transmission lines).								
18	Available infrastructure (e.g., fiber optic or wireless signal) at site to support and facilitate monitoring and management of the project/output.								
19	Current value (i.e., market/Real Estate value) of the property.								
20	Formal procedures/guidelines available to conduct/implement geothermal energy project (i.e., agreement, design, construction, and maintenance).								
21	Potential impacts of the geothermal project on road maintenance and operations (e.g., impact of geothermal system installation and maintenance).								
22	Anticipated environmental impacts and mitigation measures.								
23	Potential risk of accidents/unsafe situations (e.g., steam, water, icing, snow, roadside erosion, explosion, fire, pavement failure, clear zones, and guard rails).								
24	Compliance with Texas Highway Beautification								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
	Act (HBA).								
25	Construction plan includes measures to avoid/reduce traffic congestion, noise, unsafe situations, accidents, and other negative community impacts.								
26	Required investments in technologies and systems.								
27	Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.								
28	Permit or license required to execute/construct project, including use of underground resources.								
29	FAA has approved and granted permit for the project (i.e., if the project is located within 3-5 miles from a public or military airport).								
30	Net metering applies.								
31	Federal and State incentives, as well as Renewable Energy Credits (REC) are available.								
32	Potential concerns about "free access" to TxDOT's property (i.e., facility, land, or ROW) by third party.								
33	Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.								
34	Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).								
35	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								
36	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
37	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								
38	Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g.,								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	FHWA, DOE, and DOD).								
39	Potential conflict with zoning law, city's master plan, and transportation's plan.								
40	Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).								
41	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.								
42	Legal constraints/concerns that can impede or prevent the transaction/project, including ownership over underground resources.								
43	Patents and associated costs that could impact project/application feasibility.								
44	Available legal consultants/resources to implement TxDOT's geothermal energy program.								
45	Available legal consultants/resources to advise and review transactions and contractual agreements.								
46	Resources required to train or acquire in-house legal resources/counsel.								
47	TxDOT's exposure in terms of liability and risks (e.g., geothermal system relocation or damage).								
48	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.12: Carbon Sequestration Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement								
4	Available in-house or consultant carbon sequestration experts (i.e., carbon verifier and carbon aggregator) to participate in the implementation.								
5	Project/application will assist TxDOT in meeting carbon emission goals.								
6	Project characteristics and potential impacts on traffic, utilities, community, and environment (e.g., drainage).								
7	Site characteristics (i.e., location, soil quality, average rainfall, visibility, access, and infrastructure) that could impact project/application feasibility.								
8	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.								
9	The carbon sequestration program is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).								
10	Anticipated potential of sequestrating carbon from the existing/native vegetation.								
11	Current carbon sequestration baseline at the site has been established.								
12	Amount of "additional carbon" that is expected to potentially be sequestrated with the carbon sequestration program.								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
13	Available carbon sequestration protocol for the vegetation envisioned to be used.								
14	Carbon market (i.e., formal or informal) to trade or sell carbon credits and current carbon price (i.e., flotation) have been identified.								
15	Ability to communicate, involve, and share information about the project/application with general public and stakeholders (i.e., transparency).								
16	Formal procedures/guidelines available to conduct/implement TxDOT's carbon sequestration program (i.e., agreement, trade, and vegetation).								
17	Potential impacts of the carbon sequestration project on road maintenance and operations.								
18	Anticipated environmental impacts and mitigation measures.								
19	Potential risk of accidents/unsafe situations (e.g., safety zone, animal attraction, roadside erosion, runoff water, and guard rails).								
20	Compliance with Texas Highway Beautification Act (HBA).								
21	Current State programs (HBA, Wildflower, and Green Ribbon projects) and existing obligations to plant along the highways (i.e., that could be used to receive carbon credits).								
22	Compliance with FHWA, AASTHO, and other agency requirements.								
23	Federal and State incentives, as well as Renewable Energy Credits (REC) are available.								
24	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								
25	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
26	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
27	Potential concerns anticipated by the General Land Office (GLO) or another public agency (e.g., FHWA, DOE, DOD, and utility company).								
28	Potential conflict with zoning law, city's master plan, and transportation's plan								
29	Anticipated political and public opposition to carbon sequestration project (e.g., controversy and potential impacts triggered by the "new" project).								
30	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.								
31	Legal constraints/concerns that can impede or prevent the transaction/project, including participation in carbon market and ownership over carbon credits.								
32	Available legal consultants/resources to implement TxDOT carbon sequestration program.								
33	Available legal consultants/resources to advise and review transactions and contractual agreements.								
34	Resources required to train or acquire in-house legal resources/counsel.								
35	TxDOT's exposure in terms of liability and risks (e.g., damage on vegetation).								
36	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.13: Biomass & Biofuel Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement								
4	Interested parties (i.e., farmers or private companies) have been identified or approached TxDOT.								
5	Available in-house or consultant biomass & biofuel specialists (e.g., agronomist).								
6	Project/application will assist TxDOT in meeting renewable energy and carbon emission goals.								
7	Project characteristics and potential impacts on traffic, utilities, community, and environment (e.g., drainage and property value).								
8	Site characteristics (i.e., location, soil quality and compaction, average rainfall, ease to mow, logistics, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.								
9	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.								
10	The biomass & biofuel program is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).								
11	Needs for fertilize, herbicide, and/or irrigation.								
12	Potential yield and biofuel production capacity of the crop/vegetation.								
13	Available biomass & biofuel market to trade or								

#	Statement	Feasibility				Impact			
		Technical	**Legal**	**Economic**		**Political/ Public**	**Environmental**	**Safety**	**Social**
	process biomass (e.g., biorefinery).								
14	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
15	Current value (i.e., market/Real Estate value) of the property.								
16	Formal procedures/guidelines available to conduct/implement TxDOT's biomass & biofuel program (i.e., agreement, trade, biofuel refine, and farming procedures).								
17	Potential impacts of biomass & biofuel program on road maintenance and operations (e.g., impacts of planting, harvesting, and transporting biomass).								
18	Anticipated environmental impacts and mitigation measures.								
19	Potential risk of accidents/unsafe situations (e.g., safety zone, machinery access, animal attraction, roadside erosion, runoff water, and guard rails).								
20	Compliance with Texas Highway Beautification Act (HBA) and Wildflower program.								
21	Current State programs (HBA, Wildflower, and Green Ribbon projects) and existing obligations to plant along the highways (i.e., that could be used to extract biomass & biofuel).								
22	Existing training requirements (i.e., safety) and traffic control plan to staff and third parties involved in planting and harvesting.								
23	Compliance with FHWA, AASTHO, and other agency requirements.								
24	Permit or license required to execute/construct project (e.g., agricultural activities on public land).								
25	Federal and State incentives, as well as Renewable Energy Credits (REC) are available.								
26	Potential concerns about "free access" to TxDOT's property (i.e., land and ROW) by third								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	party.								
27	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								
28	Anticipated benefits to the region or state (e.g., increase local or state taxes).								
29	Anticipated benefits to TxDOT (e.g., financial, technical, and safety).								
30	Potential concerns anticipated by the General Land Office (GLO) or another public agency (e.g., FHWA, DOE, DOD, and utility company).								
31	Potential conflict with zoning law, city's master plan, and transportation's plan.								
32	Anticipated political and public opposition to biomass & biofuel project (e.g., controversy and potential impacts triggered by the "new" project).								
33	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.								
34	Legal constraints/concerns that can impede or prevent the transaction/project, including ownership over biomass harvested.								
35	Patents and associated costs that could impact project/application feasibility.								
36	Available legal consultants/resources to implement TxDOT biomass & biofuel program.								
37	Available legal consultants/resources to advise and review transactions and contractual agreements.								
38	Resources required to train or acquire in-house legal resources/counsel.								
39	TxDOT's exposure in terms of liability and risks (e.g., damage on plantation).								
40	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Table II.14: Wildlife Crossing Evaluation Matrix

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
1	Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.								
2	In-house staff member to champion the evaluation and implementation of the VEA.								
3	Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.								
4	Available in-house staff to specify and oversee design and construction of the project.								
5	Available in-house or consultant wildlife crossing experts to conduct and advise design concept.								
6	Target species (e.g., deer, reptiles, and small mammals) have been identified.								
7	Available data/information on animal migratory routes and movement (i.e., hot spot location).								
8	Project characteristics and potential impacts on traffic and community (e.g., habitat integration and wildlife preservation).								
9	Site characteristics (i.e., location, clearances, visibility, and infrastructure) that could impact project/application feasibility.								
10	Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.								
11	Frequency of occurrence of fatal accidents resulted from vehicle-animal-crash at the site and potential reduction with the wildlife crossing project.								
12	The wildlife crossing project is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).								
13	Available infrastructure (e.g., fiber optic and								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	wireless signal) at the site to support and facilitate monitoring and management of effectiveness and use of the wildlife crossing project.								
14	Ability to communicate, involve, and share information with general public and stakeholders about the VEA project (i.e., transparency and equal access to information).								
15	Formal procedures/guidelines available to conduct/implement TxDOT's wildlife crossing program (i.e., agreement, design, construction, and maintenance).								
16	Potential impacts of the wildlife crossing project on road maintenance and operations.								
17	Anticipated environmental impacts and mitigation measures.								
18	Potential risk of accidents/unsafe situations (e.g., clear zone, clear sight, lighting, signs, traffic control, access, fence, and guard rail, as well as during construction) and mitigation measurements.								
19	Existing training requirements (i.e., safety) and traffic control plan to staff and third parties involved in the construction of the wildlife crossing.								
20	Compliance with FHWA, AASTHO, and other agency requirements.								
21	Permit or license required to execute/construct project.								
22	Federal and State funds and/or incentives for wildlife crossing projects are available.								
23	Anticipated sponsors for wildlife crossing projects (e.g., ONGs and insurance companies).								
24	Anticipated car insurance cost reduction.								
25	Anticipated direct and indirect jobs created and economic development impacts resulting from the project.								
26	Anticipated benefits to TxDOT (e.g., financial,								

#	Statement	Feasibility				Impact			
		Technical	Legal	Economic		Political/ Public	Environmental	Safety	Social
	technical, and safety).								
27	Potential concerns anticipated by the General Land Office (GLO) or another public agency (e.g., FHWA, DOE, DOD, and utility company).								
28	Potential conflict with zoning law, city's master plan, and transportation's plan.								
29	Anticipated political and public opposition to wildlife crossing project (e.g., controversy and potential impacts triggered by the "new" project).								
30	Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), including incentives, sponsorship, and donation.								
31	Legal constraints/concerns that can impede or prevent the transaction/project.								
32	Available legal consultants/resources to implement TxDOT's wildlife crossing program.								
33	Available legal consultants/resources to advise and review transactions and contractual agreements.								
34	Resources required to train or acquire in-house legal resources/counsel.								
35	TxDOT's exposure in terms of liability and risks (i.e., during construction and after completion).								
36	Investment required by TxDOT to implement the VEA.								
Total contribution of the criterion									

Step 14: Graph of VEAs according to their feasibility and impact scores.

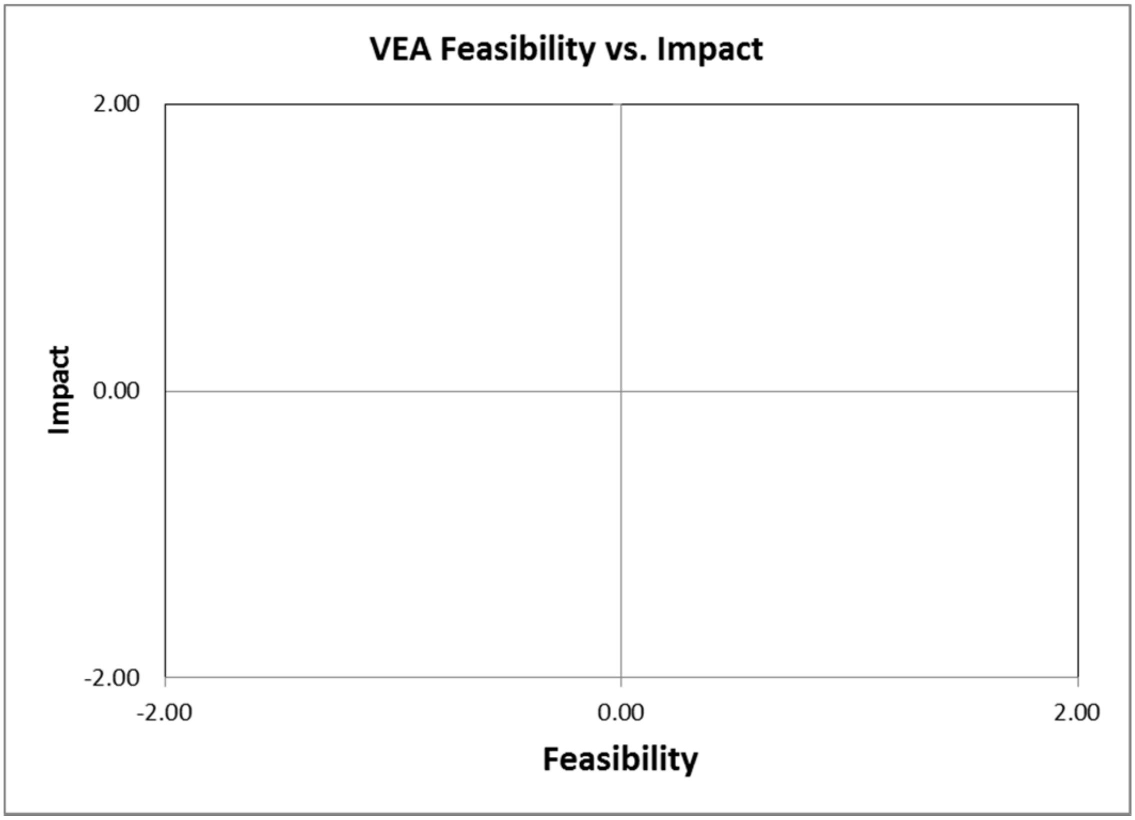


Figure II.56: Example of Feasibility vs. Impact Chart

Step 16: List of stakeholders and a chart comparing them (interest vs. influence).

Value Extraction Application Framework

List of Stakeholders: Property Management

Stakeholder	Influence	Interest
Local government		
Zoning/Planning department	0	0
Mayor/Council	0	0
State government & Legislators	0	0
Nearby landowners	0	0
Nearby Businesses	0	0
General public	0	0
Potential buyers, Developers, or Investors	0	0
TXDOT Employees	0	0
Transit agency	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Environmental Agencies	0	0
General Land Office (GLO)	0	0

Figure II.57: List of Stakeholders of Airspace Leasing (Property Management)

Value Extraction Application Framework

List of Stakeholders: Rest Areas

Stakeholder	Influence	Interest
Local government		
Zoning/Planning department	0	0
Mayor/Council	0	0
State government & Legislators	0	0
Nearby landowners	0	0
Nearby Businesses	0	0
General public	0	0
Potential Developers or Investors	0	0
TXDOT Employees	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Utility providers	0	0
Environmental Agencies	0	0
Community Representatives	0	0
General Land Office (GLO)	0	0

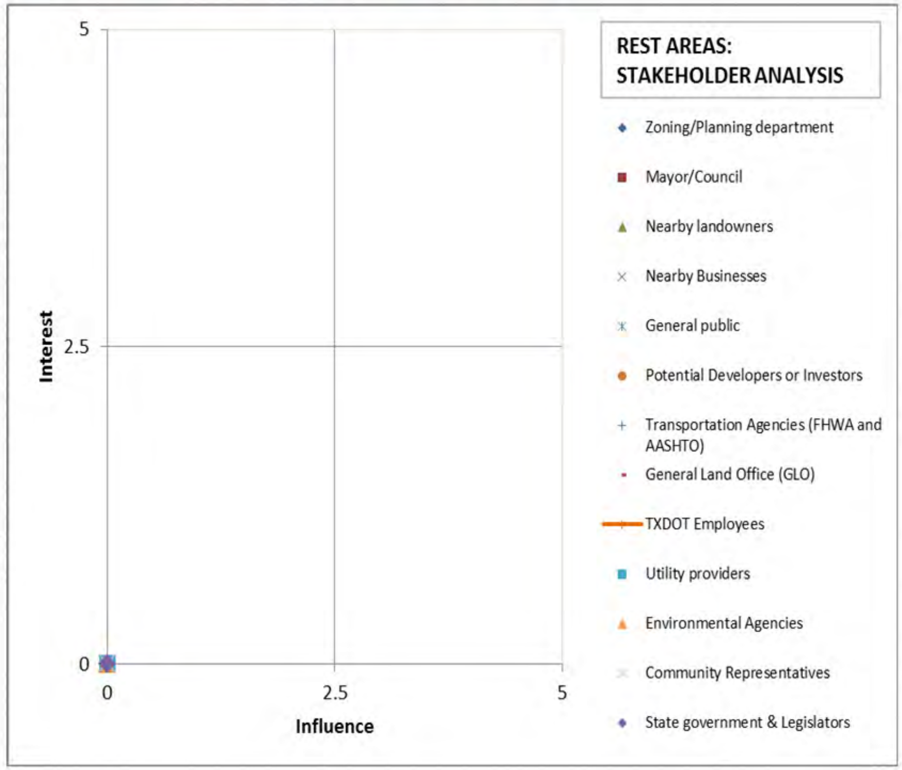


Figure II.58: List of Stakeholders of Airspace Leasing for Rest Areas

Value Extraction Application Framework

List of Stakeholders: Airspace Leasing - Buildings

Stakeholder	Influence	Interest
Local government		
Zoning/Planning department	0	0
Mayor/Council	0	0
Nearby landowners	0	0
Nearby Businesses	0	0
Nearby Residents	0	0
General public	0	0
Potential Developers	0	0
TXDOT Employees	0	0
Transit agency	0	0
Utility providers	0	0
Environmental Agencies	0	0
Community Representatives	0	0
Transportation Agencies (FHWA and AASHTO)	0	0

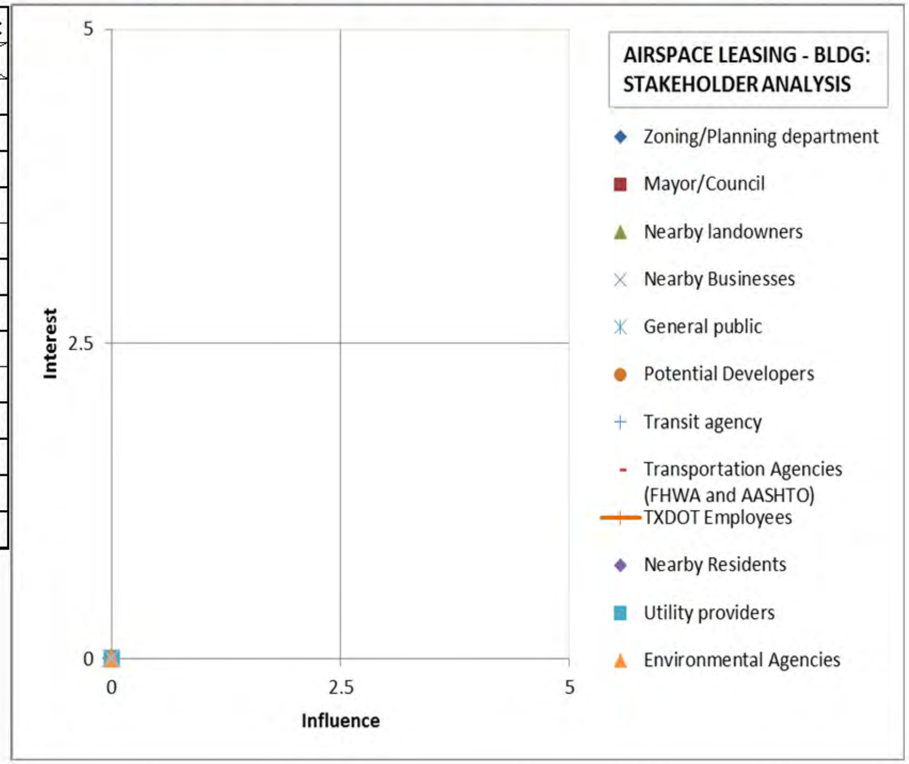


Figure II.59: List of Stakeholders of Airspace Leasing for Buildings

Value Extraction Application Framework

List of Stakeholders: Airspace Leasing – Parking Lot

Stakeholder	Influence	Interest
Local government		
Zoning/Planning department	0	0
Mayor/Council	0	0
Public Works/Transportation department	0	0
Nearby landowners	0	0
Nearby Businesses	0	0
Nearby Residents	0	0
General public	0	0
Police and Fire Departments	0	0
TXDOT Employees	0	0
Transit agency	0	0
Environmental Agencies	0	0
Community Representatives	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Department of Public Safety	0	0

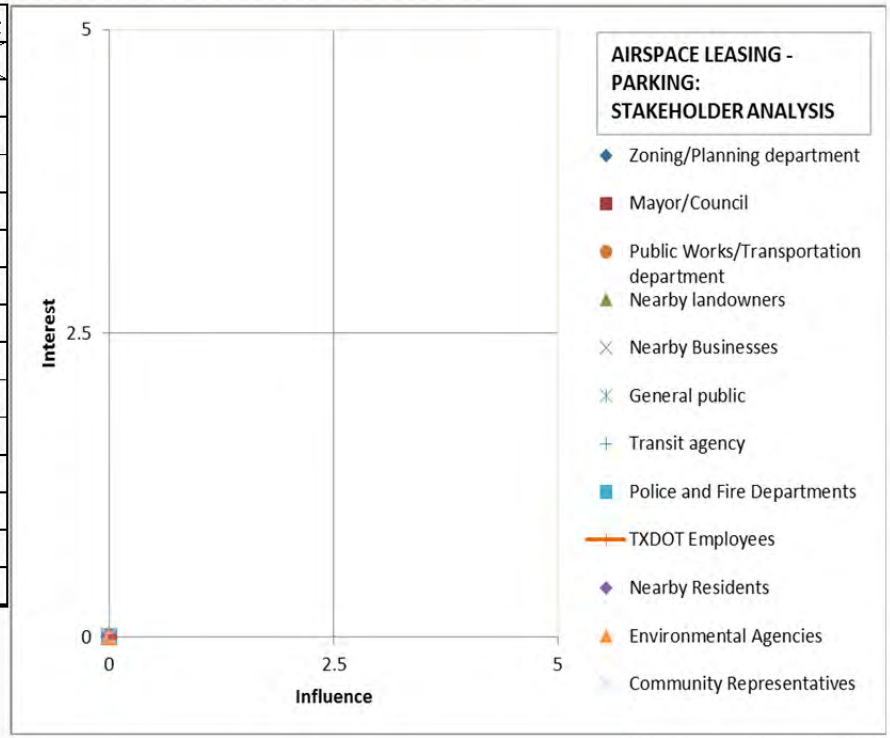


Figure II.60: List of Stakeholders of Airspace Leasing (Parking Lot)

Value Extraction Application Framework

List of Stakeholders: Airspace Leasing – Utilities & Telecommunication

Stakeholder	Influence	Interest
Local government		
Zoning/Planning department	0	0
Mayor/Council	0	0
Utility providers	0	0
Telecommunication Companies	0	0
Tower Leasing Companies	0	0
Oil & Gas Companies	0	0
General public	0	0
Nearby Residents	0	0
Nearby landowners	0	0
TXDOT Employees	0	0
Transit agency	0	0
Federal Aviation Administration (FAA)	0	0
Environmental Agencies	0	0
Community Representatives	0	0
State representatives for district	0	0
Transportation Agencies (FHWA and AASHTO)	0	0

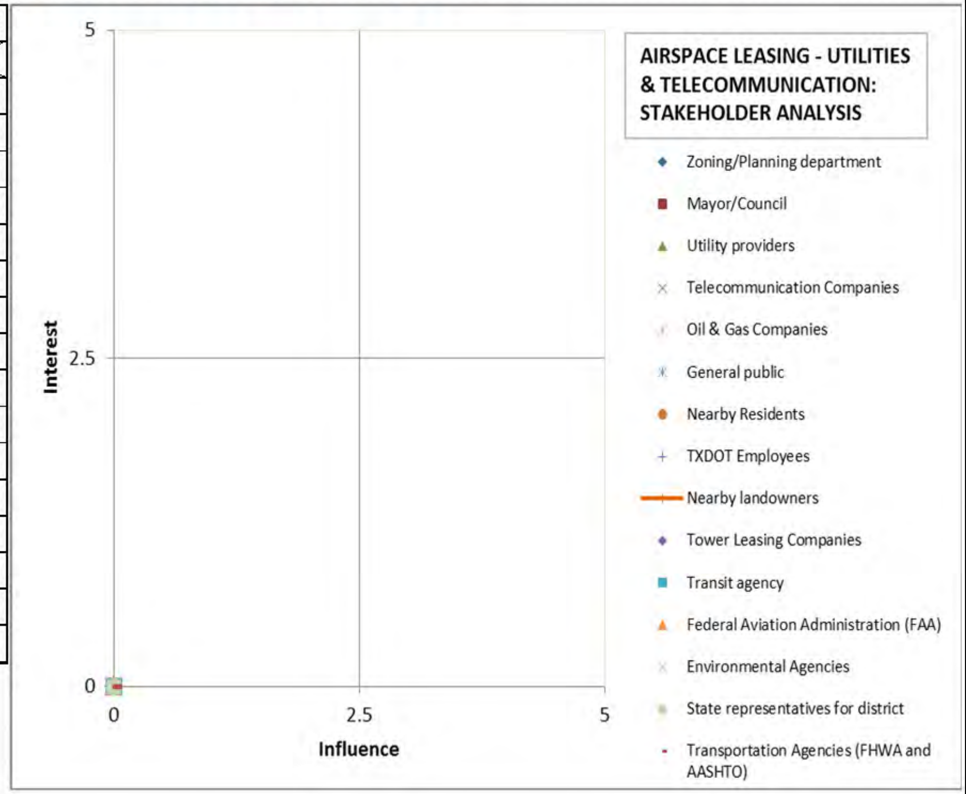


Figure II.61: List of Stakeholders of Airspace Leasing for Utilities

Value Extraction Application Framework

List of Stakeholders: Advertising

Stakeholder	Influence	Interest
State government & legislators	0	0
Local Zoning/Planning department	0	0
Advertising and Marketing Companies	0	0
Nearby landowners	0	0
Nearby Businesses	0	0
Nearby Residents	0	0
General public	0	0
TXDOT Employees	0	0
Transit agency	0	0
Environmental Agencies	0	0
Transportation Agencies (FHWA and AASHTO)	0	0

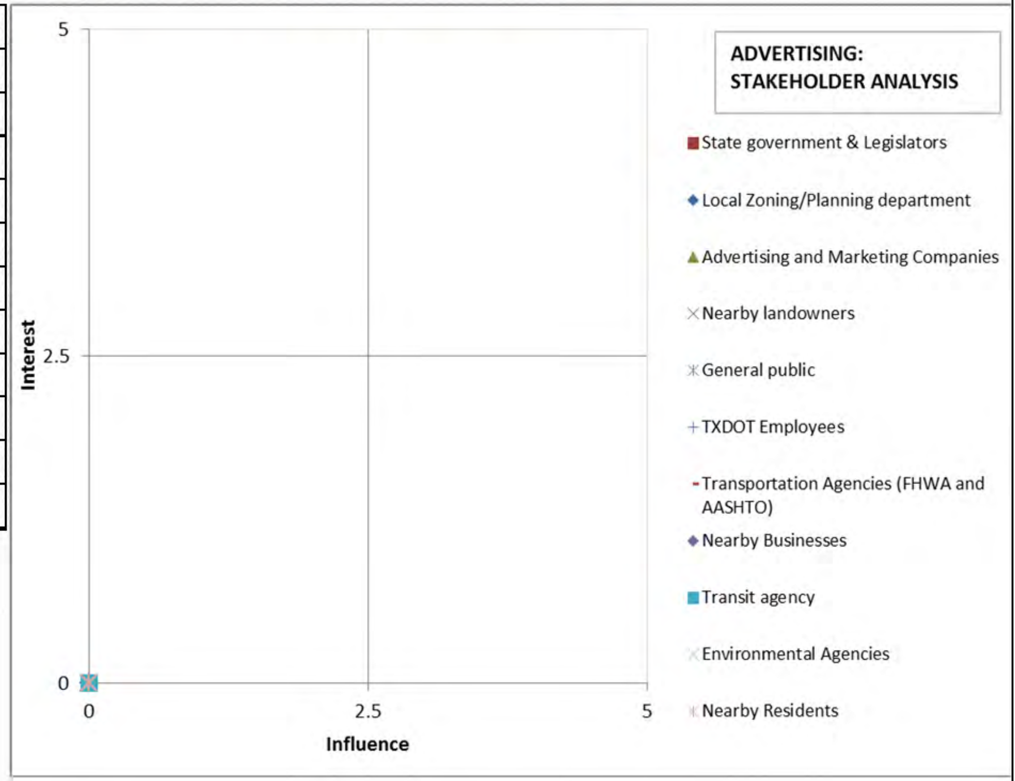


Figure II.62: List of Stakeholders of Advertising

Value Extraction Application Framework

List of Stakeholders: Solar Panels

Stakeholder	Influence	Interest
Local government		
Public Works/City/DOT	0	0
Mayor/Council	0	0
Zoning/Planning department	0	0
State government & Legislators	0	0
Nearby landowners	0	0
Community Representatives	0	0
General public	0	0
Developers or Investors	0	0
TXDOT Employees	0	0
Transit agency	0	0
General Land Office (GLO)	0	0
Utility providers	0	0
Department of Energy (DOE)	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Federal Aviation Administration (FAA)	0	0
Environmental Agencies	0	0
Solar Panel Vendors	0	0
Telecommunication Companies	0	0
Department of Defense (DOD)	0	0

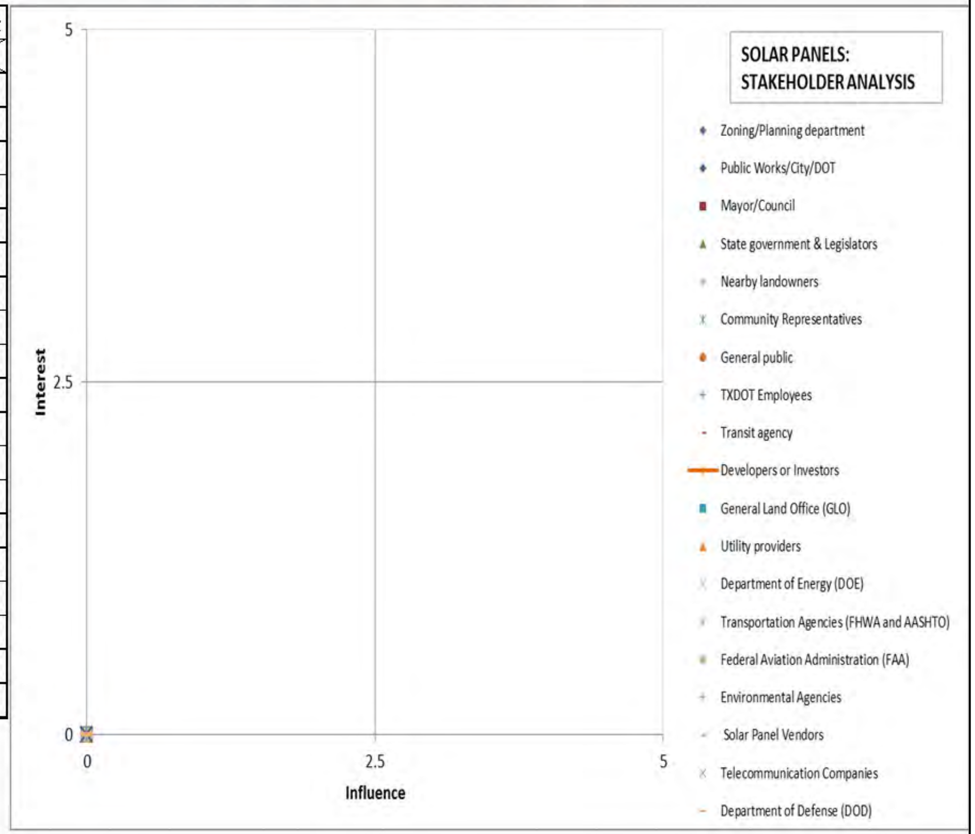


Figure II.63: List of Stakeholders of Solar Panels

Value Extraction Application Framework

List of Stakeholders: Wind Turbines

Stakeholder	Influence	Interest
Local government		
Public Works/City/DOT	0	0
Mayor/Council	0	0
Zoning/Planning department	0	0
State government & Legislators	0	0
Nearby landowners	0	0
Community Representatives	0	0
General public	0	0
Developers or Investors	0	0
TXDOT Employees	0	0
Transit agency	0	0
General Land Office (GLO)	0	0
Utility providers	0	0
Department of Energy (DOE)	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Federal Aviation Administration (FAA)	0	0
Environmental Agencies	0	0
Wind Turbine Vendors	0	0
Telecommunication Companies	0	0
Department of Defense (DOD)	0	0

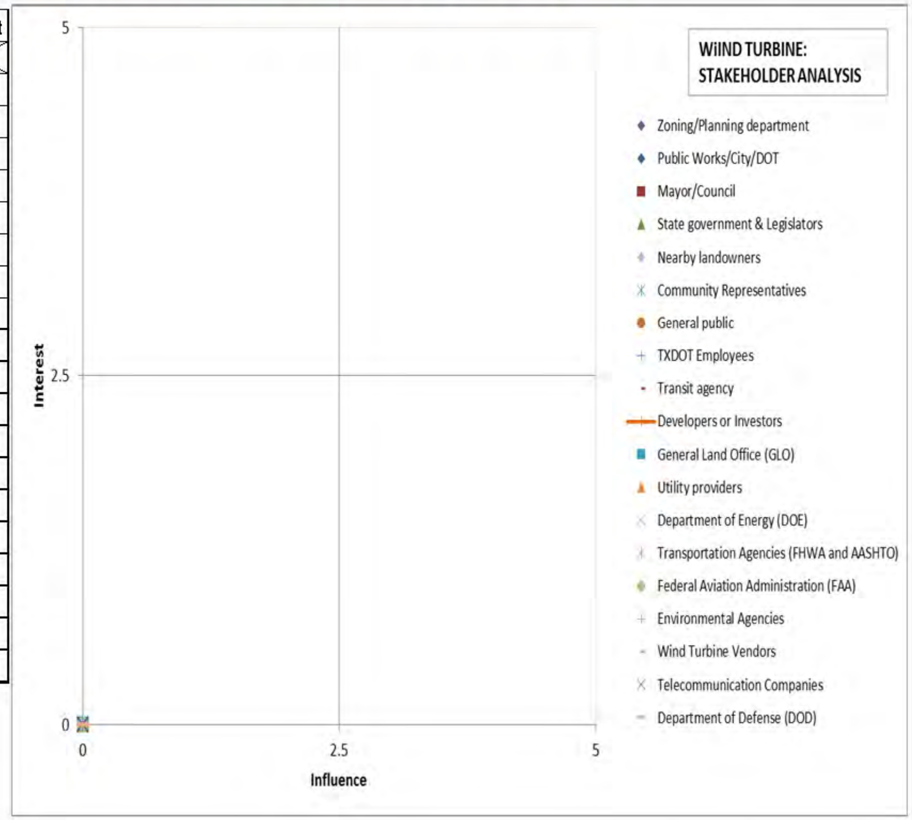


Figure II.64: List of Stakeholders of Wind Turbine

Value Extraction Application Framework

List of Stakeholders: Geothermal Energy

Stakeholder	Influence	Interest
Local government		
Public Works/City/DOT	0	0
Mayor/Council	0	0
Zoning/Planning department	0	0
State government & Legislators	0	0
Nearby landowners	0	0
Community Representatives	0	0
General public	0	0
Developers or Investors	0	0
TXDOT Employees	0	0
Transit agency	0	0
General Land Office (GLO)	0	0
Utility providers	0	0
Department of Energy (DOE)	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Federal Aviation Administration (FAA)	0	0
Environmental Agencies	0	0
Geothermal System Vendors	0	0
Department of Defense (DOD)	0	0

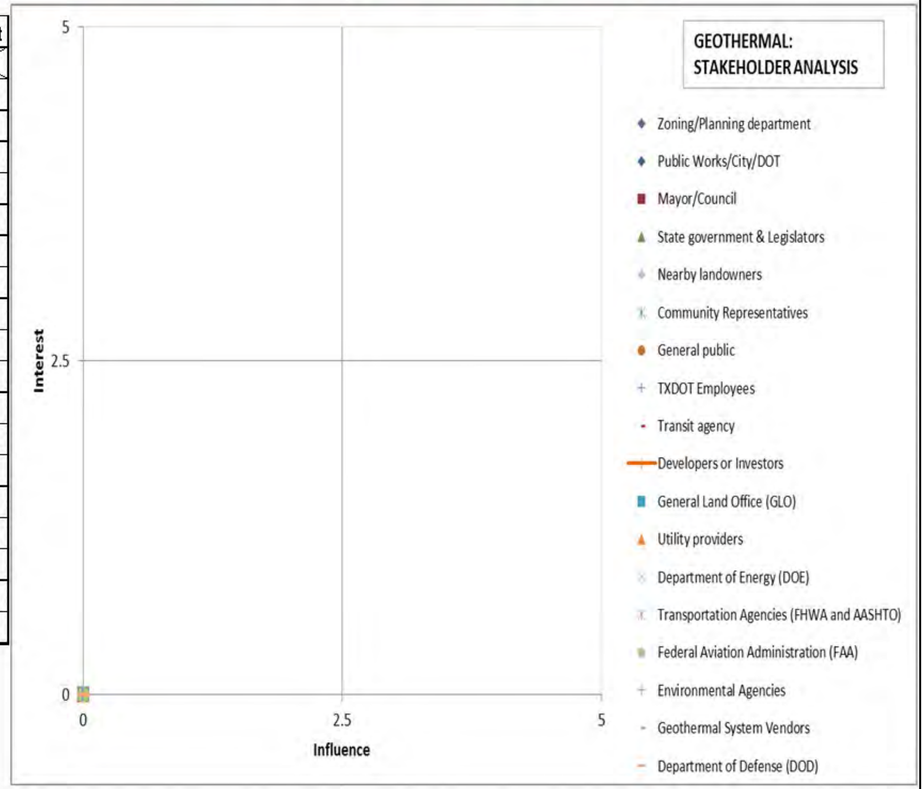


Figure II.65: List of Stakeholders of Geothermal Energy

Value Extraction Application Framework

List of Stakeholders: Carbon Sequestration

Stakeholder	Influence	Interest
Local government		
Public Works/City/DOT	0	0
Zoning/Planning department	0	0
State government & Legislators	0	0
Nearby landowners	0	0
General public	0	0
Developers or Investors	0	0
TXDOT Employees	0	0
General Land Office (GLO)	0	0
Utility providers	0	0
Department of Energy (DOE)	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Environmental Agencies	0	0
Carbon Sequestration Experts	0	0
Carbon Market Personnel	0	0

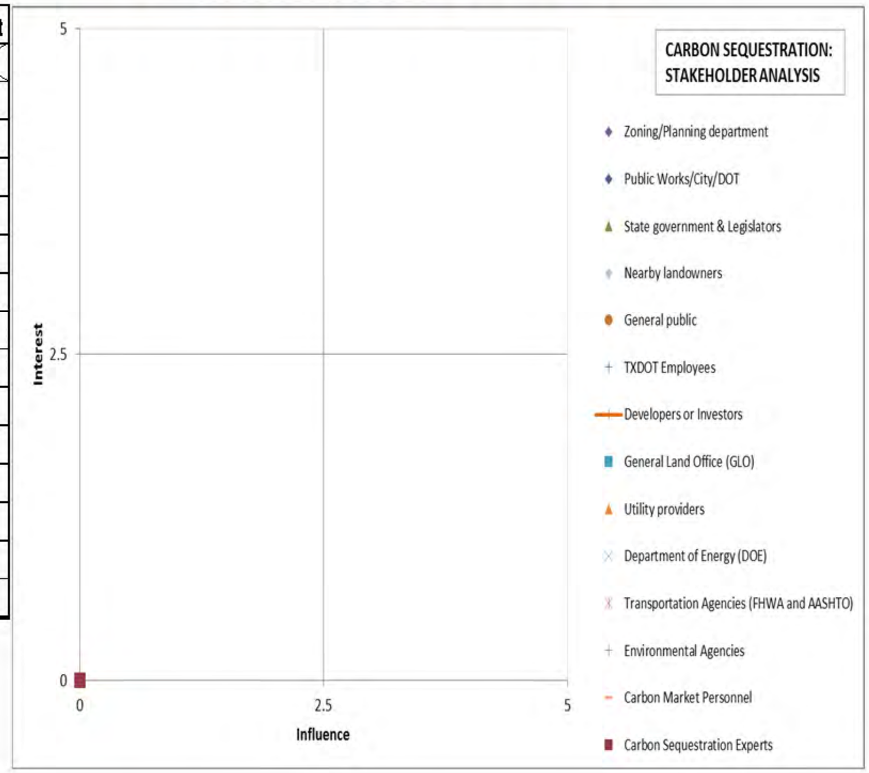


Figure II.66: List of Stakeholders of Carbon Sequestration

Value Extraction Application Framework

List of Stakeholders: Biomass & Biofuel

Stakeholder	Influence	Interest
Local government		
Public Works/City/DOT	0	0
Mayor/Council	0	0
Zoning/Planning department	0	0
State government & Legislators	0	0
Nearby landowners or Farmers	0	0
Community Representatives	0	0
General public	0	0
Developers or Investors	0	0
TXDOT Employees	0	0
Transit agency	0	0
General Land Office (GLO)	0	0
Utility providers	0	0
Department of Energy (DOE)	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Environmental Agencies	0	0
Biofuel Suppliers (i.e., Gas Stations)	0	0
Biofuel Companies (i.e., Biorefineries)	0	0

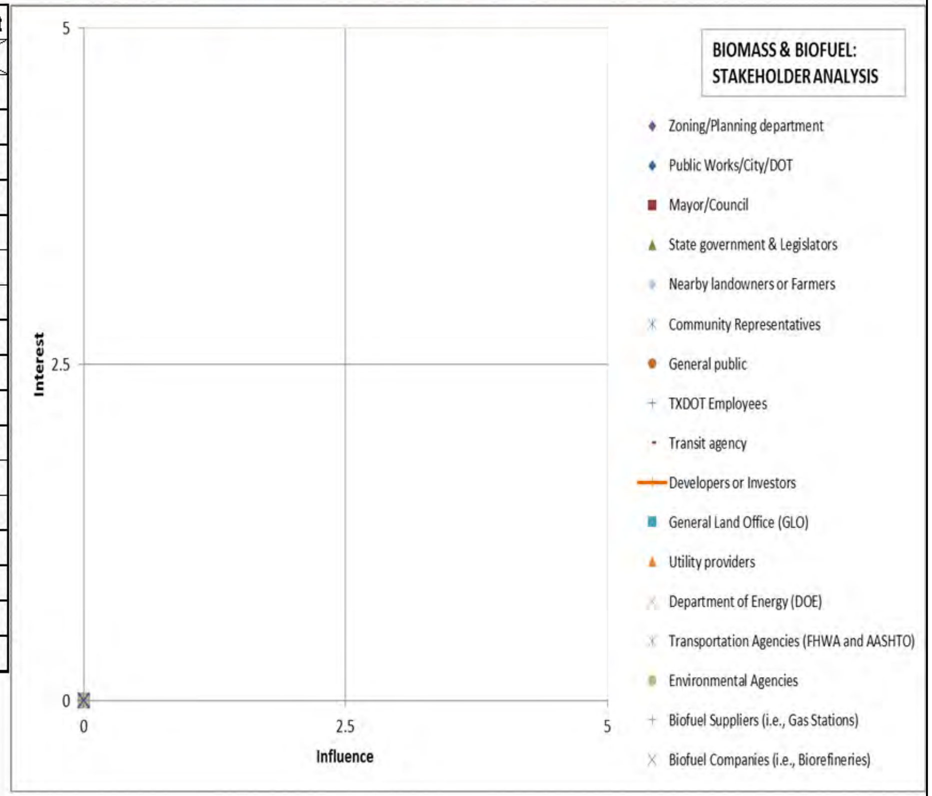


Figure II.67: List of Stakeholders of Biomass & Biofuel

Value Extraction Application Framework

List of Stakeholders: Wildlife Crossing

Stakeholder	Influence	Interest
Local government		
Public Works/City/DOT	0	0
Mayor/Council	0	0
Zoning/Planning department	0	0
State government & Legislators	0	0
Nearby landowners	0	0
Community Representatives	0	0
General public	0	0
Developers or Investors	0	0
TXDOT Employees	0	0
Transit agency	0	0
General Land Office (GLO)	0	0
Insurance Companies	0	0
Transportation Agencies (FHWA and AASHTO)	0	0
Environmental Agencies	0	0
Department of Defense (DOD)	0	0

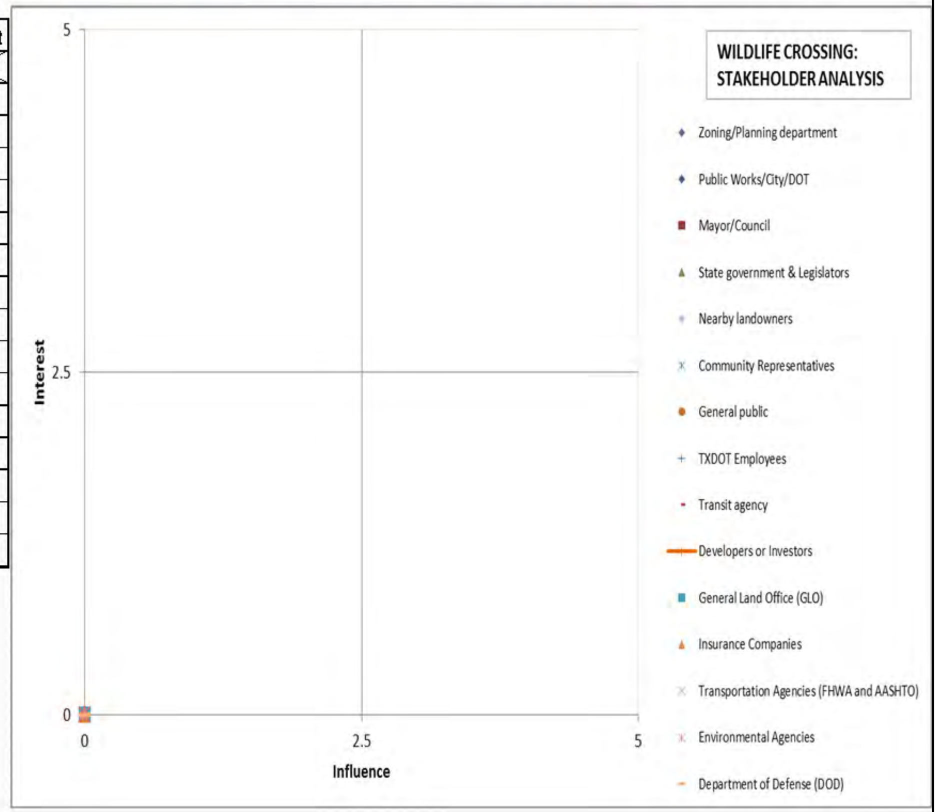


Figure II.68: List of Stakeholders of Wildlife Crossing

Appendix III: Characteristics of the Asset and Implications on VEA

Vacant Land

1. Is the property in a prime real estate location?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Property Management

2. Is the property in an urban center or commercial area or near a community center?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Parking Lot

3. Is the property adjacent to or near a residential or commercial area?
   Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine
Enhance Environment	Wind Turbine

4. Does the property have good easy access (or can access be secured)?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Parking Lot

5. When will the property be developed (i.e., in how many years)?
   Answer: < 5 years

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, Biomass & Biofuel, and Carbon Sequestration
Increase Revenue Stream	Solar Panels, Wind Turbine, Leasing—Utility, Geothermal Energy, Parking Lot, and Biomass & Biofuel
Enhance Environment	Solar Panels, Wind Turbine, Geothermal Energy, and Biomass & Biofuel

   Answer: 5 years < > 20 years

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels and Wind Turbine
Increase Revenue Stream	Solar Panels, Wind Turbine, and Geothermal Energy

6. Is the property exposed to high traffic volumes?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Advertising
Increase Revenue Stream	Advertising
Enhance Environment	Solar Panels, Wind Turbine, Geothermal Energy, and Biomass & Biofuel

7. How large (acres) is the property?
   Answer: < 5acres

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Solar Panels, Biomass & Biofuel, and Wind Turbine

8. Is the property on a flat terrain (or on a terrain with slope less than 20%)?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine and Biomass & Biofuel
Increase Revenue Stream	Wind Turbine, Parking Lot, and Biomass & Biofuel
Enhance Environment	Wind Turbine, and Biomass & Biofuel

9. Does the property have good sun exposure (i.e., no sunlight obstruction)?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels
Increase Revenue Stream	Solar Panels

10. How far (miles) is the nearest a transmission line or electricity user/customer to the property?
    Answer: > 1 miles

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Solar Panels, Wind Turbine, and Geothermal Energy

11. Is the property in a Competitive Renewable Energy Zone?
    Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine

12. Is the property free of any wind obstructions (e.g., buildings, mountains, and hills)?
Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine
Enhance Environment	Wind Turbine

13. Is the property being mowed?
Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Biomass & Biofuel and Carbon Sequestration
Increase Revenue Stream	Carbon Sequestration

14. Can mowing of the property be halted?
Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Carbon Sequestration
Increase Revenue Stream	Carbon Sequestration
Enhance Environment	Carbon Sequestration

15. What is the predominant vegetation on the property?
Answer: TREE

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, Biomass & Biofuel, and parking lot
Increase Revenue Stream	Solar Panels, Wind Turbine, Parking Lot, Geothermal Energy, Biomass & Biofuel, Carbon Sequestration, and Advertising
Enhance Environment	Solar Panels, Wind Turbine, Geothermal, and Biomass & Biofuel

Answer: NONE

Objective	Unfeasible Value Extraction Application
Save Cost	Carbon Sequestration and Biomass & Biofuel
Increase Revenue Stream	Carbon Sequestration

16. What is the average rainfall at the property?
Answer: < 15 INCHES

Objective	Unfeasible Value Extraction Application
Save Cost	Biomass & Biofuel
Increase Revenue Stream	Biomass & Biofuel
Enhance Environment	Biomass & Biofuel

17. How far (miles) is the nearest biorefinery to the property?
Answer: > 50 MILES

Objective	Unfeasible Value Extraction Application
Save Cost	Biomass & Biofuel
Increase Revenue Stream	Biomass & Biofuel
Enhance Environment	Biomass & Biofuel

Right-of-way (ROW)

1. How much ROW area (acres) besides the safety zone is available?
Answer: < 5acres

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Solar Panels, Biomass & Biofuel, and Wind Turbine

2. What is the ROW width (feet) after excluding the safety zone?
Answer: < 10ft

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, Wildlife Crossing, and Biomass & Biofuel
Increase Revenue Stream	Solar Panels, Wind Turbine, and Biomass & Biofuel
Enhance Environment	Solar Panels, Wind Turbine, Wildlife Crossing, and Biomass & Biofuel

3. Is the ROW in a prime real estate location?
Answer: NO

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Airspace leasing- Buildings

4. Is the ROW in an urban center or commercial area or near a community center?
Answer: NO

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Parking Lot

5. When will the ROW be used (i.e., in how many years)?
Answer: < 5 years

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, Leasing—Utilities, Wildlife Crossing, Geothermal Energy, and Biomass & Biofuel
Increase Revenue Stream	Solar Panels, Wind Turbine, Leasing—Utility, Parking Lot, Carbon Sequestration, and Biomass & Biofuel

Enhance Environment	Wildlife Crossing, Carbon Sequestration, and Biomass & Biofuel

Answer: 5 years < > 20 years

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels and Wind Turbine
Increase Revenue Stream	Solar Panels, Wind Turbine, and Carbon Sequestration
Enhance Environment	Wildlife Crossing

6. Does the site have good easy access (or can access be secured)?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, Biomass & Biofuel, and Leasing—Utilities
Increase Revenue Stream	Solar Panels, Wind Turbine, Leasing—Utility, Parking Lot, Biomass & Biofuel, and Airspace Leasing—Buildings
Enhance Environment	Solar Panels, Wind Turbine, and Biomass & Biofuel

7. Is the ROW exposed to high traffic volume?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Advertising
Increase Revenue Stream	Advertising
Enhance Environment	Solar Panels, Wind Turbine, and Biomass & Biofuel

8. Is the ROW on the Federal network?
   Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Advertising
Increase Revenue Stream	Advertising

9. Is the site on a flat terrain (or a terrain with a slope less than 20%)?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine and Biomass & Biofuel
Increase Revenue Stream	Wind Turbine, Parking Lot, and Biomass & Biofuel
Enhance Environment	Wind Turbine, and Biomass & Biofuel

10. Is the site impacted by flooding, wetlands, or protected streams?

Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, and Leasing—Utilities
Increase Revenue Stream	Solar Panels, Wind Turbine, Leasing—Utility, Parking Lot, Airspace Leasing—Buildings, and Advertising
Enhance Environment	Solar Panels and Wind Turbine

11. Has documented endangered or threatened flora or fauna been identified on or adjacent to the site?

Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, Biomass & Biofuel, and Leasing—Utilities
Increase Revenue Stream	Solar Panels, Wind Turbine, Leasing—Utility, Parking Lot, Biomass & Biofuel, and Airspace Leasing—Buildings
Enhance Environment	Solar Panels, Wind Turbine, and Biomass & Biofuel

12. Is the site on a designated state or federal scenic corridor or in a protected viewshed?

Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, and advertising
Increase Revenue Stream	Solar Panels, Wind Turbine, Airspace Leasing—Buildings, and Advertising
Enhance Environment	Solar Panels and Wind Turbine

13. Have any cultural or historic artifacts been identified on or adjacent to the site?

Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, Leasing—Utilities, and Biomass & Biofuel
Increase Revenue Stream	Solar Panels, Wind Turbine, Leasing—Utility, Parking Lot, Biomass & Biofuel, and Airspace Leasing – Buildings
Enhance Environment	Solar Panels, Wind Turbine, and Biomass & Biofuel

14. Is this a site with a high occurrence of animal-vehicle-crash accidents?
    Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wildlife Crossing
Enhance Environment	Wildlife Crossing

15. Does the site have good sun exposure (i.e., no sunlight obstruction)?
    Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels
Increase Revenue Stream	Solar Panels

16. How far (miles) is the nearest transmission lines or potential electricity user/customers to the site?
    Answer: > 1 miles

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Solar Panels and Wind Turbine

17. Is the site adjacent to or near a residential or commercial area?
    Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine
Enhance Environment	Wind Turbine

18. Is there any utility infrastructure on the site (including buried utilities)?
    Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, and Carbon Sequestration
Increase Revenue Stream	Solar Panels, Wind Turbine, Parking Lot, Biomass & Biofuel, and Carbon Sequestration
Enhance Environment	Solar Panels and Wind Turbine

19. Is the ROW in a Competitive Renewable Energy Zone?
    Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine

20. Is the site free of any wind obstructions (e.g., buildings, mountains, and hills)?
    Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine

Increase Revenue Stream	Wind Turbine
Enhance Environment	Wind Turbine

21. Is the ROW being mowed?
    Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Biomass & Biofuel and Carbon Sequestration
Increase Revenue Stream	Carbon Sequestration

22. Can mowing of the ROW be halted?
    Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Carbon Sequestration
Increase Revenue Stream	Carbon Sequestration
Enhance Environment	Carbon Sequestration

23. What is the predominant vegetation on the site?
    Answer: TREE

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, Biomass & Biofuel, and Advertising
Increase Revenue Stream	Solar Panels, Wind Turbine, Parking Lot, Biomass & Biofuel, Advertising, Airspace Leasing – Buildings, and Carbon Sequestration
Enhance Environment	Solar Panels, Wind Turbine, and Biomass & Biofuel

Answer: NONE

Objective	Unfeasible Value Extraction Application
Save Cost	Carbon Sequestration and Biomass & Biofuel
Increase Revenue Stream	Carbon Sequestration

24. What is the average rainfall at the site?
    Answer: < 15 INCHES

Objective	Unfeasible Value Extraction Application
Save Cost	Biomass & Biofuel
Increase Revenue Stream	Biomass & Biofuel
Enhance Environment	Biomass & Biofuel

25. How far (miles) is the closest biorefinery?
Answer: > 50 MILES

Objective	Unfeasible Value Extraction Application
Save Cost	Biomass & Biofuel
Increase Revenue Stream	Biomass & Biofuel
Enhance Environment	Biomass & Biofuel

26. Does it snow/ice at this location?
Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Geothermal Energy

Offices and Facilities

1. Is the building in a prime real estate location?
Answer: NO

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Property Management

2. Is the building in an urban center or residential or commercial area?
Answer: YES

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Wind Turbine

3. Is it an old building with high maintenance cost?
Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Property Management

4. Is the building's electricity consumption relatively high?
Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, and Geothermal Energy

5. Is the building's HVAC energy consumption relatively high?
Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Geothermal Energy

6. Does the building have good sun exposure (i.e., no sunlight obstruction)?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels
Increase Revenue Stream	Solar Panels

7. Is the building in a Competitive Renewable Energy Zone?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine

8. Is the building at a site that is free from wind obstruction (e.g., other buildings, mountains, and hills)?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine
Enhance Environment	Wind Turbine

9. Is the building critical and essential to TxDOT's future operations (i.e., cannot be replaced)?
   Answer: YES

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Property Management

10. Is the building fully occupied and utilized?
    Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Property Management (IF QUESTION 3 is NO)

11. Does the building site have any antenna tower or is there available area to install an antenna/radio tower at the site?
    Answer: NO

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Leasing—Utility

12. For how long does TxDOT plan to occupy and/or own the property?
    Answer: < 20 years

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels and Wind Turbine
Increase Revenue Stream	Solar Panels, Wind Turbine, and Geothermal Energy

Rest Areas

1. Is the rest area on a Federal network?
   Answer: YES

Objective	Unfeasible Value Extraction Application
Save Cost	Property Management
Increase Revenue Stream	Property Management

2. How far (miles) is the rest area from the nearest transmission lines?
   Answer: > 1 miles

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Solar Panels, Wind Turbine, Geothermal Energy

3. How far (miles) is the rest area from the nearest business or community area?
   Answer: < 30 miles

Objective	Unfeasible Value Extraction Application
Save Cost	Property Management
Increase Revenue Stream	Property Management

4. Is the rest area's electricity consumption relatively high?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels, Wind Turbine, and Geothermal Energy

5. Is the rest area's HVAC energy consumption relatively high?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Geothermal Energy

6. Does the rest area have good sun exposure (i.e., no sunlight obstruction)?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Solar Panels
Increase Revenue Stream	Solar Panels

7. Is the rest area located in a Competitive Renewable Energy Zone?
   Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine

8. Is the rest area at a site that is free from wind obstruction (e.g., buildings, mountains, and hills)?

Answer: NO

Objective	Unfeasible Value Extraction Application
Save Cost	Wind Turbine
Increase Revenue Stream	Wind Turbine

9. How large (acres) is the rest area site that is vacant (i.e., excluding the area used for buildings, parking, etc.)?

Answer: < 5acres

Objective	Unfeasible Value Extraction Application
Increase Revenue Stream	Solar Panels and Wind Turbine

Appendix IV: Summary of Advantages and Disadvantages of VEA

Property Management

Advantages

- Provide full control and awareness of the agency's inventory, needs, and opportunities.
- Does not present any substantial technical challenge.
- Simple communication tools such as emails, Craig's list, and TxDOT website can be used to disseminate information and reach out likely interested parties.
- Can promote economic development and create jobs
- Increases tax payment by private sector (state and federal Taxes)
- Can help TxDOT to build more efficient and updated facilities (e.g., barter transaction)
- Can enhance TxDOT decision making process
- Can enable TxDOT to have better understanding of its needs and make better and wiser investments and expenditures (i.e., budget allocation).
- State law enables TxDOT to lease any real property held or controlled by the agency that is not needed for highway purpose.
- TxDOT can resort to GSC and/or GLO for specialized skills on asset planning, management, and disposition.
- Can enhance internal and cross-departmental communication.

Disadvantages / Requirements

- Requires investment on in-house staff with knowledge of best practices in efficient, least-cost space utilization and functional adjacencies, real estate market interaction for acquisition/disposition pricing, financial feasibility determinations, transaction structuring (where values and complexities warrant), strategic plan preparation that is proactive and anticipatory of future needs, and financial optimization.
- Requires a systematic and comprehensive property evaluation process (i.e., annually).
- Investment in an efficient information system (e.g., website, database, and GIS) and asset management capable of rendering real-time information to facilitate the decision making process
- Potential impacts of the new use on nearby neighborhood, community, business, and traffic
- Potential conflict with highway system future needs.
- Potential political and public opposition
- Requires a formalized, clear, and public (open) process (i.e., fair market price, equal opportunity to interested parties, auction, and bid). Ensure total transparency.
- May require some licenses and permits
- Intensive contractual and legal work to clearly state responsibilities, liabilities, rights, duties, and other agreements (e.g., period, price, new use)

Property Management (Rest Area)

Advantages

- Can avoid closure of or even increase the number of rest areas.
- Can provide cleaner and safer rest areas (i.e., hygiene and security)
- Can enhance the service on rest areas (e.g., ATM, gas station, and food).
- Rest Areas are essential for road safety and trip quality.

- Can enhance road safety (i.e., reduction of accident due "drowsing" drivers).
- Is a simple VEA and does not demand any complex technical solution and/or high investment by TxDOT
- Attractive and useful rest areas encourage travelers to use a safe location off the roadway to take a break and return more alert to the highway.
- Can promote economic development and create jobs (i.e., when it does not compete with nearby business).
- Well served and interactive rest areas and welcome centers can potentially enhance the tourism market, create jobs and, therefore, help to develop rural regions (i.e., through the improvement of the quality of road trips).
- Increases federal and state tax incomes (i.e., from private businesses and commercial activities).

Disadvantages / Requirements

- Potential political and public opposition (i.e., can be controversial).
- Potential impacts on nearby neighborhood, community, and business (i.e., Economic impacts and unfair competition)
- Federal and state laws and regulations that precludes or prohibits private and commercial rest areas
- Require investment on staff to manage, control, and oversee private rest area design, construction, and operation (i.e., compliance with standards, specifications, and requirements)
- Interference with current social projects, such as " blind vendor support"
- Need to assess best location according to traffic, access, environment, and construction requirements
- Need an intensive traffic flow to be financial attractive to private sector. Hence, it will not solve the problems in very remote areas
- Requires a formalized, clear, and public (open) process (i.e., fair market price, equal right to all interested parties, auction, and bid)
- May require licenses and permits, mainly environmental.
- Intensive contractual and legal work to clearly state responsibilities, liabilities, rights, duties, and other agreements (e.g., period, price, new use)

Airspace Leasing (Building)

Advantages

- Easy to be implemented if considered in new highway projects.
- Some projects can be attractive to business and for the public. For example, rest areas over freeways can provide entertainment for travelers, mainly kids.
- Some projects can represent city landmark and touristic sight.
- Can help reduce urban center footprint, once the structure (i.e., building) is constructed over an existing construction (i.e., road).
- Provides opportunities for financial investments and business expansion.
- Can promote economic development and create jobs.
- Increases state tax incomes.
- Has long period of revenue.
- Can integrate communities and neighborhoods divided by the highway.

Disadvantages / Requirements

- Is a complex agreement that involves legal, planning, environmental, design, construction, maintenance, safety, security, and insurance considerations to be successful implemented.
- Requires intensive and burdensome contractual and legal work to clearly state responsibilities, liabilities, rights, duties, and other agreements (e.g., period, price, new use).
- Requires involvement of all internal departments and disciplines (e.g., design, traffic, ROW, maintenance, and planning).
- Requires specialized staff to conduct the evaluation and authorization process. If no expert is available in-house, outsourcing may be needed. Mainly for safety and security assessment.
- Possible impacts on neighborhood and environment (e.g., traffic, public health, privacy, shade, noise, heat island, and visual pollution).
- Potential political and public opposition.
- Involves very robust structure and technical challenges (e.g., site constraints).
- AASHTO and the FHWA have strict design requirements for structure over highway that must be complied with (drainage, vibration, clearance, fire resistance, maintenance, and access).
- Need of a very long-term commitment to pay off. High planning, design, and construction cost. Economically feasible only in very dense urban centers (i.e., at prime location).
- Safety requirements (e.g., lighting, exhaustion, ventilation, access, fire protection, emergency access, surveillance, and tunnel signs).
- Construction requirements (e.g., structural, access, utilities, methods), plans (e.g., safety, traffic, access, and impact mitigation), and disturbances (e.g., noise, dust, and traffic congestion).
- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities).
- Cannot be used to store or manufacture flammable, explosive, or hazardous substances.
- Requires several licenses and permits (e.g., NEPA).

Airspace Leasing (Parking lot)

Advantages

- Many urban areas have inadequate parking space.
- Can promote economic and business development and, hence, create jobs.
- Increase tax payment by private sector
- Can use short-term agreement (2-5 years).
- Can enhance safety and welfare (i.e., less congestion and accidents)
- Is an easy and simple VEA, not requiring high investment and efforts.
- Can be even easier to implement if considered in new highway projects.
- Can be a better solution than curb side parking (i.e., less traffic interference and more safety conditions).
- Can attract general public support.

Disadvantages / Requirements

- FHWA and ASSTHO guidelines and requirements
- Safety requirements (e.g., fence, curb, pedestrian access, and surveillance)
- Requires some investment and study on information system (e.g., parking meter, surveillance, and security)

- Require a well-done contractual agreement with an entity insured and with financial capacity to avoid possible TxDOT liabilities over third parties' properties (i.e., vehicles) and lawsuits.
- Requires easy and free access to be viable.
- Some environmentalists and transit providers see "parking unavailability" as a way to manage and reduce single vehicle occupant use and traffic congestion.
- Can negatively impact on the neighborhood (i.e., business expansion and increase traffic can entail noise and congestion).
- Some precautions have to be taken to avoid soil and water contamination from car oil, as well as to drain rain water to the public rainwater system.
- All security and safety measures must be approved by TxDOT engineering, operation, and safety personnel.

Airspace Leasing (Utilities)

Advantages

- Enhanced and available telecommunication signals can contribute to social and educational development, as well as help promote economic development and create jobs.
- Can enhance safety in remote area (e.g., tornado warming, communication of animal carcass, existing obstacle, pavement conditions, and severe weather conditions).
- Several potential ways to implement this VEA.
- Can be even easier to implement if considered in new highway projects.
- Can provide the state access to technology infrastructure.
- Can yield a better telecommunication network , helping TxDOT and other public agencies to improve their information management systems and, consequently, enhance their services, implement an efficient maintenance program, and make better decision (i.e., wisely spend public money).
- TxDOT already has some airspace agreements for utilities that generate revenue, but not a formalized program. A formal program could bring more contracts and revenue for the agency and state.
- Some application can be implemented with a short-term agreement (5 years)
- Can facilitate the implementation or expansion of TxDOT's Advanced Rural Transportation System (ARTS), Dynamic Message Signs, 511 travel information, and Highway Advisory Radio.

Disadvantages / Requirements

- Requires license and permits such as environmental
- Need to comply with FHWA and ASSTHO guidelines and requirements, as well as NEPA. Some policies may be out of date and not address new technologies.
- Importance of contractual agreement (i.e., liabilities and responsibilities) and legal consul during the process.
- Only applicable to private utilities
- Some utilities can entail safety and environmental concerns (e.g., explosion, contamination, leak, and crash)
- May cause traffic disruption and hazardous situation during construction and maintenance. Importance of good planning and assessment, as well as access to the site.
- FHWA requires environmental evaluation and compliance with NEPA

- Requires a formalized, clear, and public (open) process (i.e., fair market price, equal right to all interested parties, auction and bid, specifications, and guidelines)
- Requires a construction and maintenance plan (i.e., access, minimize impacts on traffic, safety, and execution method)
- Some application requires special considerations such as buried depth, concrete coat, and reinforcement.
- Private companies will need to have free or partial access to ROW or public properties.
- May compete with private sector (e.g. tower companies).

Advertising

Advantages

- Is significantly simple application and provides several means to be implemented.
- Has a diversified portfolio of applications.
- Can be used to educate, warn, and guide drivers toward safer behavior (e.g., “drink-and-drive,” “no texting,” and “buckle-up”).
- Can be used to conduct public outreach, disseminate information, integrate communities, engage public participation, and share ideas.
- Can help to promote businesses, tourism activities, and, hence, economic development (mainly in rural areas).
- New technologies provide good potential and alternative to implement this VEA (e.g., website, internet, electronic screens, and TVs).
- Does not cause any environmental threat or impact.
- Programs, such as Adopt-a-Highway, can make roadside litter-free, helping to preserve fauna and flora, to avoid soil and water contamination, prevent insect proliferation and, consequently, diseases, and generate local employment.
- Programs, such as Adopt-a-Watt, Adopt-a-Highway, and Naming Rights, can foster and facilitate the implementation of other VEAs.

Disadvantages / Requirements

- Some sort of advertising are illegal and others are regulated and/or restricted by the FHWA.
- Potential political and public opposition
- Some advertising (i.e., message and content) can be controversial and lead to misinterpretation.
- Demand some precaution with controversial advertisings.
- Different regulations and laws that dictate and control the use of advertising in public assets and highway ROW.
- May require some license or permit.
- May cause visual impacts (aesthetic).
- May impact on and/or be in conflict with Texas Highway Beautification Act (HBA) and State Rural Roads Act (RRA).
- High administration cost (e.g., intensive contractual and paper work).
- Requires several “small” contracts to offset the administrative costs.
- May entail safety concerns (e.g., driver distraction and obstacle).
- Requires a formalized, clear, and public (open) process (i.e., fair market price, equal right to all interested parties, auction and bid, specifications, and guidelines).

Solar Panel (ROW and Vacant Land)

Advantages

- Has no moving part, does not require water, does not make noise, and does not produce any waste or GHG emission.
- Solar energy is a key component of the U.S. national strategy for reducing carbon footprint and promoting renewable energy.
- Texas has a great solar energy potential.
- Renewable energy has gained momentum due to “an increase in environmental awareness, skyrocket oil and gas price, and national security concerns.” Also, can protect the agency against oil price volatility.
- Texas energy production has not followed the state energy demand (i.e., consumption).
- Can help to reduce the dependence on fossil fuels and foreign energy.
- Using a value-based procurement (local vendors, maintenance expert, and workers) can promote economic development and create jobs.
- The technology is still evolving and becoming cheaper and more efficient
- Can be installed close to the end-user and with any scale (i.e., size), therefore not requiring long transmission lines and reducing heat loss—mainly in remote areas.
- Is an environmentally friendly energy source and can generate electricity without disturbing the surrounding environment or community.
- Can enhance TxDOT image and bring political and public support.
- Is easy to implement if considered in highway new projects.
- Has low maintenance frequency and cost. Further, vendors provide 25-year warranty.
- Existing incentives granted by state and federal governments and REC credits.
- Can help TxDOT meet carbon emission and renewable energy consumption goals.
- The panels can be recycled.
- Solar energy is a safe source of electricity (i.e., does not pose any risk of explosion, fire, disasters, structural failure, or accidents).
- Can promote awareness and educate general public on green energy, importance of carbon reduction, and renewable energy.

Disadvantages / Requirements

- Feasibility and efficiency is very local-driven.
- Require a high up-front investment, what entails a long payback and commitment period.
- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities).
- Involves a public-private partnership, therefore an intensive and burdensome contractual and legal work.
- Can use several, but complex, business models that vary according to the shared risks, liabilities, electricity buyer, and renewable energy credits.
- Has some patent issues.
- May cause some impacts on nearby communities (i.e., property value).
- Works only during the day (i.e., sunlight); otherwise need batteries or other electricity source.
- Relies upon the weather conditions, requiring batteries or other electricity source for more reliability
- Requires a clean, easy, independent, and safe access (i.e., aside the main road).
- Must comply with FHWA and ASSTHO regulations regarding the use of ROW.

- May need some security precaution against theft and vandalism
- Require considerations and a plan on the solar panel disposal, once the panels are composed by heavy metals, such as cadmium. Need a recycle program.
- May raise some safety concerns (e.g., roadside obstruction and driver's distraction), but site or guardrail can resolve these issues.
- Zoning law can preclude or impede the implementation.
- Has a low energy density production (i.e., requires somewhat area)
- Is still driven by incentives.
- May impact on Texas Highway Beautification Act.

Solar Panel (Building and Rest Area)

Advantages

- Has no moving part, does not require water, does not make noise, and does not produce any waste or GHG emission.
- Solar energy is a key component of the U.S. national strategy for reducing carbon footprint and promoting renewable energy.
- Texas has a great solar energy potential.
- Renewable energy has gained momentum due to "an increase in environmental awareness, skyrocket oil and gas price, and national security concerns." Also, can protect the agency against oil price volatility.
- Texas energy production has not followed the state energy demand (i.e., consumption).
- Can help to reduce the dependence on fossil fuels and foreign energy.
- Using a value-based procurement (local vendors, maintenance expert, and workers) can promote economic development and create jobs.
- The technology is still evolving and becoming cheaper and more efficient
- Can be installed close to the end-user and with any scale (i.e., size), therefore not requiring long transmission lines and reducing heat loss—mainly in remote areas.
- Is an environmentally friendly energy source and can generate electricity without disturbing the surrounding environment or community.
- Can enhance TxDOT image and bring political and public support.
- Is easy to implement if considered in new buildings.
- Has low maintenance frequency and cost. Further, vendors provide 25-year warranty.
- Existing incentives granted by state and federal governments and REC credits.
- Can help TxDOT meet carbon emission and renewable energy consumption goals.
- The panels can be recycled.
- Solar energy is a safe source of electricity (i.e., does not pose any risk of explosion, fire, disasters, structural failure, or accidents).
- May not Involves a public-private partnership.
- Can promote awareness and educate general public on green energy, importance of carbon reduction, and renewable energy.

Disadvantages / Requirements

- Feasibility and efficiency is very local-driven.
- Require a high up-front investment, what entails a long payback and commitment period.
- May involves a public-private partnership, therefore an intensive and burdensome contractual and legal work.

- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities).
- Can use several, but complex, business models that vary according to the shared risks, liabilities, electricity buyer, and renewable energy credits.
- May cause some impacts on nearby communities (i.e., property value).
- Works only during the day (i.e., sunlight); otherwise need batteries or other electricity source.
- Relies upon the weather conditions, requiring batteries or other electricity source for more reliability
- May need some security precaution against theft and vandalism
- Require considerations and a plan on the solar panel disposal, once the panels are composed by heavy metals, such as cadmium. Need a recycle program.
- Zoning law can preclude or impede the implementation.
- Has a low energy density production (i.e., requires somewhat area)
- May require some update and/or revamp on the existing electrical installation and systems.
- Is still driven by incentives.

Wind Turbine (ROW and Vacant Land)

Advantages

- Some regions of Texas (i.e., CREZ) has a great wind energy potential
- New technologies (i.e., small wind turbines) can help to overcome space issues, reduce up-front investment, and others barriers.
- Has high electricity production per area
- Does not require water and does not produce any waste or GHG emission.
- Can generate energy any time of the day.
- Wind turbine is a key component of the U.S. national strategy for reducing carbon footprint and promoting renewable energy.
- Renewable energy has gained momentum due to "an increase in environmental awareness, skyrocket oil and gas price, and national security concerns." Also, can protect the agency against oil price volatility.
- Texas energy production has not followed the state energy demand (i.e., consumption).
- Can help to reduce the dependence on fossil fuels and foreign energy.
- Using a value-based procurement (local vendors, maintenance expert, and workers) can promote economic development and create jobs.
- The technology is still evolving and becoming cheaper and more efficient
- Can be installed close to the end-user and with any scale (i.e., size), therefore not requiring long transmission lines and reducing heat loss—mainly in remote areas.
- Is an environmentally friendly energy source
- Can enhance TxDOT image and bring political and public support.
- Is easy to implement if considered in highway new projects.
- Existing incentives granted by state and federal governments and REC credits.
- Can help TxDOT meet carbon emission and renewable energy consumption goals.
- Can promote awareness and educate general public on green energy, importance of carbon reduction, and renewable energy.
- Is more cost-efficient than other renewable energy source (i.e., $ per KWh generated) and is still evolving.
- Involves intense work-force, contributing thus for employment.

Disadvantages / Requirements

- Feasibility and efficiency (i.e., energy production) is very local-driven.
- Can highly impacts on nearby communities and environment (e.g., property value, noise, bird kill, shade, oil leaks, visual aesthetics, tourism, public safety, and quality of life, visual intrusion, and flickering of light)
- Has somewhat intensive maintenance
- Need of construction and maintenance plan (i.e., transport, minimal distance between turbines, installation, access, and maintenance procedures). Can potentially impact on traffic and road structure.
- Require a high up-front investment, what entails a long payback and commitment period.
- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities).
- Involves a public-private partnership, therefore an intensive and burdensome contractual and legal work.
- Can use several, but complex, business models that vary according to the shared risks, liabilities, electricity buyer, and renewable energy credits.
- Has some patent issues.
- May cause some impacts on nearby communities (i.e., property value).
- Relies somewhat upon the weather conditions , requiring batteries or other electricity source for more reliability
- May impact on Texas Highway Beautification Act.
- Requires a clean, easy, independent, and safe access (i.e., aside the main road).
- Must comply with FHWA and ASSTHO regulations regarding the use of ROW.
- May raise some safety concerns (e.g., roadside obstruction, blade failure, oil spill on the road, turbine catching on fire, and driver's distraction), but site can resolve these issues.
- Zoning law can preclude or impede the implementation (e.g., height limit).
- The wind turbine/system must comply with local electrical code requirements, the National Electrical Code (NEC), and Fire Protection Association.
- May require some licenses and permits (e.g., FAA permit)
- Can interfere on telecommunication, radio, internet, TV, and radar signals
- Is still driven by incentives.

Wind Turbine (Building and Rest Area)

Advantages

- Some regions of Texas (i.e., CREZ) has a great wind energy potential
- New technologies (i.e., small wind turbines) can help to overcome space issues, reduce up-front investment, and others barriers.
- Has high electricity production per area
- Does not require water and does not produce any waste or GHG emission.
- Can generate energy any time of the day.
- Wind turbine is a key component of the U.S. national strategy for reducing carbon footprint and promoting renewable energy.
- Renewable energy has gained momentum due to "an increase in environmental awareness, skyrocket oil and gas price, and national security concerns." Also, can protect the agency against oil price volatility.
- Texas energy production has not followed the state energy demand (i.e., consumption).

- Can help to reduce the dependence on fossil fuels and foreign energy.
- Using a value-based procurement (local vendors, maintenance expert, and workers) can promote economic development and create jobs.
- The technology is still evolving and becoming cheaper and more efficient
- Can be installed close to the end-user and with any scale (i.e., size), therefore not requiring long transmission lines and reducing heat loss—mainly in remote areas.
- Is an environmentally friendly energy source
- Can enhance TxDOT image and bring political and public support.
- Is easy to implement if considered in new buildings.
- Existing incentives granted by state and federal governments and REC credits.
- Can help TxDOT meet carbon emission and renewable energy consumption goals.
- Can promote awareness and educate general public on green energy, importance of carbon reduction, and renewable energy.
- Is more cost-efficient than other renewable energy source (i.e., $ per KWh generated) and is still evolving.
- Involves intense work-force, contributing thus for employment.

Disadvantages / Requirements

- Feasibility and efficiency (i.e., energy production) is very local-driven.
- Can highly impacts on nearby communities and environment (e.g., property value, noise, bird kill, shade, oil leaks, visual aesthetics, tourism, public safety, and quality of life, visual intrusion, and flickering of light)
- Has somewhat intensive maintenance
- Need of construction and maintenance plan (i.e., transport, minimal distance between turbines, installation, access, and maintenance procedures).
- Require a high up-front investment, what entails a long payback and commitment period.
- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities).
- May involves a public-private partnership, therefore an intensive and burdensome contractual and legal work.
- Can use several, but complex, business models that vary according to the shared risks, liabilities, electricity buyer, and renewable energy credits.
- May cause some impacts on nearby communities (i.e., property value).
- Relies somewhat upon the weather conditions , requiring batteries or other electricity source for more reliability
- May raise some safety concerns (e.g., blade failure, oil spill, and turbine catching on fire).
- Zoning law can preclude or impede the implementation (e.g., height limit).
- The wind turbine/system must comply with local electrical code requirements, the National Electrical Code (NEC), and Fire Protection Association.
- May require some licenses and permits (e.g., FAA permit)
- Can interfere on telecommunication, radio, internet, TV, and radar signals
- Is still driven by incentives.

Geothermal Energy

Advantages

- Does not depend on weather conditions, day-time, or season. Therefore, does not require back-up battery.
- Geothermal power plants are reliable and can be implemented anywhere (i.e., urban center and remote areas) in any scale.
- Can be implemented in small scale and almost everywhere in Texas.
- Can be installed close to the end-user and with any scale (i.e., size), therefore not requiring long transmission lines and reducing heat loss—mainly in remote areas.
- Is an environmentally friendly energy source
- Geothermal Heat Pump can be used anywhere in Texas and have short payback period
- Geothermal Heat Pump is regarded as the most energy-efficient, environmentally clean, and cost-effective method of temperature control.
- Is a key component of the U.S. national strategy for reducing carbon footprint and promoting renewable energy.
- Renewable energy has gained momentum due to "an increase in environmental awareness, skyrocket oil and gas price, and national security concerns." Also, can protect the agency against oil price volatility.
- Texas energy production has not followed the state energy demand (i.e., consumption).
- Can help to reduce the dependence on fossil fuels and foreign energy.
- Can enhance TxDOT image and bring political and public support.
- Is easy to implement if considered in highway new projects.
- Existing incentives granted by state and federal governments and REC credits.
- Can help TxDOT meet carbon emission and renewable energy consumption goals.
- Can promote awareness and educate general public on green energy, importance of carbon reduction, and renewable energy.
- May not Involves a public-private partnership.
- Geothermal power plant has comparatively small surface footprint.
- Can be used as de-icing mechanisms for pavement, therefore enhancing safety, reducing costs, and avoiding contamination of roadside soil by chemical and salty substances

Disadvantages / Requirements

- Type of application and feasibility are highly dependent on the underground characteristics and quality of the resource (i.e., temperature, depth, fluid characteristics, ease, and rate the fluid can be extracted and reinjected). Its cost can significantly increase if the useful resource is located deep (i.e., high drilling cost).
- Geothermal power plant has a medium to long payback period
- Geothermal power plant requires a formalized procedure (i.e., impact evaluation, contractual agreements, liabilities, licenses, and permits)
- May involve a public-private partnership, therefore an intensive and burdensome contractual and legal work.
- Can use several, but complex, business models that vary according to the shared risks, liabilities, electricity buyer, and renewable energy credits.
- May have some patent issues.
- May cause some impacts on nearby communities and/or wildlife habitat (i.e., property value, noise, steam).

- May raise some safety concerns (e.g., steam).
- Zoning law can preclude or impede the implementation (e.g., height limit).
- May require some licenses and permits (e.g., NEPA permit)
- May involve a high up-front investment, depending the size and complex of the system.
- May raise issues regarding ownership and use of natural and underground resources. May require involvement of NEPA and environmental agencies.
- Its major issue is perhaps the use of water. Geothermal energy production requires large volume of water that often contains dissolved toxic substances.
- May raise some environmental concerns (i.e., water consumption and aquifer contamination).
- May require some precaution to avoid explosion and/or fire when drilling wells.

Carbon Sequestration

Advantages

- Can help to reduce carbon footprint and combat global warming
- Can help to enhance TxDOT image
- Vegetation on ROW can be beneficial to road preservation (i.e., erosion prevention and reduction)
- Can help enhance the habitat surrounding the road and create a natural barrier for animals, helping preserve species.
- Can improve air quality by reducing the amount of CO2 and GHG on the atmosphere. Therefore, can help to prevent human respiratory diseases and enhance life quality.
- Can help TxDOT to divert and concentrate more focus and investments on highway system improvements (i.e., new projects and pavement maintenance), thereby potentially generating societal benefits such as: job creation, less traffic congestion, and lower freight costs (i.e., lower food, material, and product prices).
- Can enhance road safety and prevent roadside erosion (e.g., help preserve the pavement)
- Can provide a natural protection barrier for coastal roads, along hills and valleys, and against animals, thereby reducing animal-vehicle collisions and accidents.
- The federal government has given special attention to these types of applications in U.S. congressional debates centered preceding national climate change legislation. Therefore, it can bring political and public support.
- Some state beautification programs, such as the Green Ribbon Project—a corridor aesthetic and landscape master plan—requires TxDOT to plant a certain number of bushes and trees per year along TxDOT ROW. TxDOT could potentially receive credits from these programs. Also, bushes and trees absorb more carbon than grass and flowers (i.e., more efficient).

Disadvantages / Requirements

- Has to be clearly demonstrated as additional amount of carbon is being sequestrated to be counted and considered as carbon credit.
- The potential carbon that can be sequestrated varies with the site characteristics (i.e., soil, vegetation, and weather). Further, Texas has an enormous variability of soil and weather conditions that directly influences the capacity, feasibility, and cost of sequestrating carbon
- Requires involvement of very specialized staff (i.e., carbon aggregator and carbon verifier).
- Requires a long-term commitment (i.e., around 30 years) to qualify for carbon sequestration program.
- May impact on Texas Highway beautification program (i.e., wildflower program).

- May impose some safety concerns (e.g., some vegetation can attract animals, be a roadside obstruction, and reduce visibility and sight range).
- Carbon credit does not have a solid and well-established market yet. Carbon price floats, making economic analysis uncertain, complex, and difficult.
- There is no conclusive research on the efficiency of carbon sequestration, the establishment of a carbon baseline, and the real rate of carbon sequestrated by grass. Also, lacks of established protocol for grass vegetation.
- May raise some concerns from utility providers about liability on any damage on the vegetation planted along the ROW. Utility providers will seek and lobby to have priority over a carbon sequestration program application (long-term commitment)
- Lacks of regulations and/or direction in terms of the DOT's ownership on carbon credits generated by vegetation management practices on federal lands and how these carbon credits can be traded by a public agency.

Biomass and Biofuel

Advantages

- Texas contains one of the most diverse and most accommodating growing environments in the United States, and boasts a plethora of potential biomass-based renewable energy sources.
- The areas along the Gulf Coast and Northeast have the highest potential for biomass production because of existing refining capacity, strong producer networks, and available fertile land.
- Can promote economic development and create jobs
- The equipment used is similar to mowing equipment.
- Activities undertaken are very similar to mowing activities.
- Can produce biofuel without competing with food market.
- Can reduce and solve roadside maintenance and pest control problems.
- Requires low up-front investment
- Vegetation on ROW can be beneficial to road preservation (i.e., erosion prevention and reduction). Also, a good vegetation management strategy enhances road safety and prevents erosion. Vegetation along highway ROW defers erosion by reducing landslides, controlling evasive plant species, retaining storm water, and holding snow (i.e., living snow fence).
- Same precautions and traffic control used to mowing activities can be adapted to plant and harvest crops.
- Biofuel combustion emits considerable less carbon than fossil fuel.
- The ethanol and biodiesel market has gained prominence worldwide due to increasing fossil fuel prices and pollution concerns.
- Can help to avoid the expansion of farming into environmentally sensitive areas; a commonly challenge found with conventional biofuel production
- Biofuel is non-toxic to humans and animals as well as biodegradable (i.e., disposal and waste are absorbed by the environment without being polluting).
- Using DOT ROW for biomass production can thus reduce the need for using farm land for energy crop production; thereby alleviating pressure on food and other commodities' price.

Disadvantages / Requirements

- Its feasibility and productivity (cost-effectiveness) depends on soil and weather conditions. Further, the production of each specific crop will largely be determined by available land, rainfall, competition, producer interest, economic incentives, and equipment needed.
- Water availability is crucial for most agriculture activity. It is generally believed that it would be very difficult to cultivate crops for biofuel production in areas with less than 14 to 16 inches of rainfall
- Logistic considerations (e.g., planting, harvesting, transporting, biorefinery, and access)
- Requires a formalized procedure (i.e., impact evaluation, contractual agreements, and liabilities). Also, questions about how to establish the business models and explore agricultural activities on public lands.
- May raise some concerns from utility providers about liability on any damage on the vegetation planted along the ROW. Utility providers will seek and lobby to have priority over a biomass production application (long-term commitment).
- May require intensive coordination with utility providers and agricultural activities such as plowing, tilling, harvesting, and mowing. Vegetation roots may impact on underground utilities (e.g., gas lines, oil lines, electricity, telephone, water, and fiber optics) that are also using the ROW. Contractual and legal issues with responsibilities and liabilities
- The use of de-icing products (e.g., salt) and run-off water can affect and change the proprieties of the soil in the ROW, hindering the growth of crops.
- Some crops and vegetation (e.g., switchgrass) has notorious difficult for establishment. Some takes up to 3 years, even when some chemical fertilizers were used.
- Investment in a GIS database that captures the geospatial characteristics of TxDOT's ROW would aid in the identification and determination of which ROW parcels are appropriate for biomass production.
- May compete with and/or affects the ongoing roadside beautification and wildflower programs. Some crops do not promote the same aesthetical effect the flowers that integrate these programs have.
- Involves several variables and uncertainties, making the economic analysis complex and unique for each circumstance.
- In Texas, the ethanol and biodiesel market is not as prominent partly because grain has mostly been produced for animal (mostly cattle) consumption.
- May impose some safety concerns (e.g., some vegetation can attract animals, be a roadside obstruction, and reduce visibility and sight range).
- Licenses and permits required to exploit public land for agricultural activities.
- Has to comply with FHWA and ASSTHO regulations.

Wildlife Crossing

Advantages

- Texas has been the state with the highest number of fatalities from animal-vehicle crashes since 1996
- FHWA "identified 21 federally listed threatened or endangered animal species in the U. S. for which road mortality was documented as a major threat to their survival. Wildlife crossing can help reduce and mitigate this problem. It can thus integrate habitats, reduce animal mortality, and help to save endangered species.
- Has been the most successful way to reduce both habitat fragmentation and wildlife-vehicle collisions caused by roads

- The construction of wildlife crossing can create jobs, usually in remote communities maximizing social benefit.
- A well designed wildlife crossing can effectively enhance the roadway safety and diminish the number of animal-vehicle accidents.
- Can reduce expenditures on road maintenance (e.g., removing animal carcass and investigating and reporting accidents). Thus, the government can direct larger portion of the budget to other priorities and, hence, benefiting the society.
- Can prevent potential lawsuit against TxDOT and liability over accidents and fatalities.
- Can reduce human fatalities, accidents, and consequently car insurance costs.
- Several federal funding programs exist to finance wildlife crossing projects
- Can be easily implemented and with lower cost if considered in new highway projects
- Can bring political and public support and enhance TxDOT image
- The implementation of wildlife crossing structures has received substantial support from the U.S. congress. The approval of a federal highway bill, i.e., the Transportation Equity Act (TEA-21), guaranteed the availability of federal funds for wildlife crossing structures on existing roads, as well as new road projects.
- All new road projects are required to have an environmental impact study and mitigation strategy for fauna and flora.
- DOT's efforts and attitudes toward the environment and wildlife preservation can be fundamental to reduce public controversy and outcry against projects.
- Several federal funding sources can be used to support and afford the construction of wildlife crossings. Further federal programs can also grant funding for wildlife crossings such as U.S. Fish and Wildlife Service (FWS), Natural Resource Assistance Grant Programs, and Cooperative Endangered Species Conservation Fund.
- Can be eligible for funding support from private foundations
- Has the highest net benefit minus cost balance in preventing animal-vehicle collisions.

Disadvantages / Requirements

- The effectiveness and efficiency of wildlife crossing structures are largely a function of the location, type, and dimensions of the crossings and, hence, are site-specific. The attributes of wildlife crossings thus have to be carefully studied and planned to accommodate the species targeted and the surrounding landscape.
- Requires extensive study and data regarding migration routes to identify the best location of the crossing (i.e., hot spot)
- Require wildlife crossing experts in the design team.
- May impose some construction challenges to be implemented in existing roads (e.g., supply chain, execution methods, and safety concerns).
- Traffic control and detours may also be required.
- Some engineering and technical solution may be inconvenient and expensive.

Appendix V: Evaluation Matrix Statements and Criteria

Property Management

1. Trained in-house staff in ROW and Real Estate management.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of a property management application.

Feasibility	Impact
Technical	
Economic	

3. Ease of integrating property management application in TxDOT's organizational and decision-making structure.

Feasibility	Impact
Technical	

4. Availability of resources to update databases and/or GIS inventory of assets.

Feasibility	Impact
Technical	Political/Public

5. In-house resource to systematically review and assess current asset and future asset needs.

Feasibility	Impact
Technical	Political/Public

6. Willingness to invest in resources such as information system, website, and GIS system.

Feasibility	Impact
Technical	Political/Public
Economic	

7. Access to TxDOT's property inventory to determine characteristics/features of property assets (e.g., size, location, value, maintenance cost, and overall condition).

Feasibility	Impact
Technical	

8. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

9. Current value (i.e., market/Real Estate value) of the property.

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

10. Current maintenance expenses on the property asset and potential savings if disposing of the property.

Feasibility	Impact
Economic	

11. Formal procedures/guidelines available to conduct/implement TxDOT property management program.

Feasibility	Impact
Technical	Political/Public
Legal	

12. Anticipated impacts on nearby community of "new" property use (i.e., new owner or lessee), including potential to mitigate anticipated impacts.

Feasibility	Impact
	Political/Public
	Environmental
	Safety
	Social

13. Anticipated environmental impacts and mitigation measurements of "new" property use.

Feasibility	Impact
Legal	Environmental
Economic	Social

14. Permit or license required for "new" property use.

Feasibility	Impact
Legal	
Economic	

15. Financial resources of and warranties (i.e., bond approval and surety) provided by the developer interested in buying/leasing/swapping property.

Feasibility	Impact
Legal	
Economic	

16. Anticipated direct and indirect jobs created and economic development impacts resulting from "new" use of property.

Feasibility	Impact
Economic	Political/Public
	Social

17. Anticipated benefits to TxDOT (e.g., financial, technical, and safety) of disposing of "obsolete" assets.

Feasibility	Impact
Technical	Political/Public
Economic	Safety
	Social

18. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	Impact
Legal	Political/Public

19. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	Impact
Legal	Political/Public
	Social

20. Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" use).

Feasibility	Impact
	Political/Public

21. Legal constraints/issues that can jeopardize the transaction.

Feasibility	Impact
Legal	

22. Available legal consultants/resources to implement TxDOT property management program.

Feasibility	Impact
Legal	
Economic	

23. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	
Economic	

24. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

25. TxDOT's exposure in terms of liability and risks.

Feasibility	Impact
Legal	Political/Public
Economic	

26. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Rest Areas

1. Trained in-house staff in ROW and Real Estate management.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. If retrofitting rest areas, available in-house staff to specify and oversee design and construction (retrofit) of rest area.

Feasibility	Impact
Technical	
Economic	

4. Available data on number of vehicles passing by (and visiting) the rest area.

Feasibility	Impact
Technical	

5. If considering privatization or a private partnership investor/developer(s) interested in managing/operating rest area.

Feasibility	Impact
Technical	
Economic	

6. Access to TxDOT rest area inventory to determine characteristics/features (e.g., size, location, value, maintenance cost, and overall condition) of rest area.

Feasibility	Impact
Technical	

7. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

8. Current value (i.e., market/Real Estate value) of the property.(i.e., rest area).

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

9. Current maintenance expenses on the rest area and potential savings from implementing the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

10. Formal procedures/guidelines available to TxDOT to implement public-private partnership agreements and or privatize rest areas.

Feasibility	Impact
Technical	Political/Public
Legal	

11. Anticipated impacts of privatizing the rest area on nearby community (i.e., economic and social impacts), including potential to mitigate anticipated impacts.

Feasibility	Impact
	Political/Public
	Environmental
	Safety
	Social

12. Anticipated environmental impacts and mitigation measures.

Feasibility	Impact
Legal	Environmental
Economic	Social

13. Permit(s) or license(s) required.

Feasibility	Impact
Legal	
Economic	

14. Financial resources of and warranties (i.e., bond approval and surety) provided by the developer interested in leasing or partnering with TxDOT.

Feasibility	Impact
Legal	
Economic	

15. Anticipated direct and indirect jobs created and economic development impacts.

Feasibility	Impact
Economic	Political/Public
	Social

16. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Safety

	Social

17. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	**Impact**
Technical	Political/Public
Economic	Safety
	Social

18. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	**Impact**
Legal	Political/Public

19. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	**Impact**
Legal	Political/Public
	Social

20. Anticipated political and public opposition to project (e.g., controversy and potential impacts triggered by rest area privatization).

Feasibility	**Impact**
	Political/Public

21. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).

Feasibility	**Impact**
Legal	Political/Public
Economic	

22. Legal constraints and barriers that can impede/preclude the project (e.g., rest area privatization).

Feasibility	**Impact**
Legal	Political/Public

23. Resources required to train and acquire in-house legal resources/counsel.

Feasibility	**Impact**
Legal	
Economic	

24. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	
Economic	

25. TxDOT's exposure in terms of liability and risks.

Feasibility	Impact
Legal	Political/Public
Economic	

26. Compliance with Interstate Oasis Program, FHWA, AASTHO, and other's agency requirements and policies.

Feasibility	Impact
Technical	Social
Legal	
Economic	

27. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Airspace Leasing: Building

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. Staff to specify and oversee design and construction of the project.

Feasibility	Impact
Technical	
Economic	

3. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

4. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.

Feasibility	Impact
Technical	Safety
Economic	

5. Project characteristics (e.g., footprint) and potential impacts on traffic, utilities, community, and environment (e.g., congestion, aesthetics, privacy, shade, and property value) that could impact project/application feasibility.

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

6. Site characteristics (i.e., location, logistics, access, environment, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

7. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

8. Current value (i.e., market/Real Estate value) of the property.in the area.

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

9. Formal procedures/guidelines available to conduct/implement an airspace leasing program (i.e., agreement, design, construction, and maintenance).

Feasibility	Impact
Technical	Political/Public
Legal	

10. The project is designed and implemented as a component/together with a new highway project (i.e., already included in the highway design).

Feasibility	Impact
Technical	
Economic	

11. Anticipated impacts of the project (i.e., "new owner or lessee") on nearby community (e.g., traffic congestion, shade, privacy, noise, and property values, including potential to mitigate anticipated impacts.

Feasibility	Impact
	Political/Public
	Environmental
	Safety
	Social

12. Anticipated environmental impacts and mitigation measure for "new" property use/project.

Feasibility	Impact
Legal	Environmental
Economic	Social

13. Construction plan includes measures to avoid/reduce traffic congestion, dust, noise, unsafe situations, accidents, and other negative community impacts.

Feasibility	Impact
Technical	Environmental
Economic	Safety
	Social

14. Traffic control plan during construction and anticipated safety training required.

Feasibility	Impact
Technical	Safety
Economic	

15. Building and tunnel comply with all safety requirements (e.g., lighting, exhaustion, ventilation, drainage, access, and fire protection).

Feasibility	Impact
Technical	Safety
Economic	

16. Compliance with FHWA, AASTHO, and other agency requirements.

Feasibility	Impact
Technical	Safety
Legal	
Economic	

17. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

18. Permit or license required to execute/construct project.

Feasibility	Impact
Legal	
Economic	

19. Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.

Feasibility	Impact
Legal	
Economic	

20. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

21. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Safety
	Social

22. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Political/Public
Economic	Safety

	Social

23. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	**Impact**
Legal	Political/Public

24. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	**Impact**
Legal	Political/Public
	Social

25. Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	**Impact**
	Political/Public

26. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).

Feasibility	**Impact**
Legal	Political/Public
Economic	

27. Legal constraints/concerns that can impede or prevent the transaction/project.

Feasibility	**Impact**
Legal	

28. Available legal consultants/resources to implement TxDOT's airspace leasing program.

Feasibility	**Impact**
Legal	
Economic	

29. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	**Impact**
Legal	
Economic	

30. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

31. TxDOT's exposure in terms of liability and risks.

Feasibility	Impact
Legal	Political/Public
Economic	

32. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Airspace Leasing Parking Lot

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.

Feasibility	Impact
Technical	Safety
Economic	

4. Current demand/need for additional parking space in the area.

Feasibility	Impact
Economic	Political/Public
	Social

5. Project characteristics and potential impacts on traffic, utilities, community, and environment (e.g., drainage and runoff) that could impact project/application feasibility.

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

6. Site characteristics (i.e., location, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

7. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

8. Current value (i.e., market/Real Estate value) of the property.

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

9. Formal procedures/guidelines available to conduct/implement an airspace leasing program (i.e., agreement, design, construction, and maintenance).

Feasibility	Impact
Technical	Political/Public
Legal	

10. The parking lot is designed and implemented as a component/together with a new highway project (i.e., already included in the highway design).

Feasibility	Impact
Technical	
Economic	

11. Anticipated traffic impacts of the new parking lot.

Feasibility	Impact
	Political/Public
	Environmental
	Safety
	Social

12. Anticipated environmental impacts and mitigation measure for parking lot project.

Feasibility	Impact
Legal	Environmental
Economic	Social

13. Construction plan includes measures to avoid/reduce traffic congestion, dust, noise, unsafe situations, accidents, and other negative community impacts.

Feasibility	Impact
Technical	Environmental
Economic	Safety
	Social

14. Required investments in technologies and systems (e.g., parking meters and surveillance systems).

Feasibility	Impact
Technical	
Economic	

15. Compliance with FHWA, AASTHO, and other agency requirements.

Feasibility	Impact
Technical	Safety
Legal	
Economic	

16. Parking lot design complies with safety requirements (e.g., curbs, fences, lighting, access, fire protection, pedestrian access, and surveillance).

Feasibility	Impact
Technical	Safety
Economic	

17. Permit or license required to execute/construct project.

Feasibility	Impact
Legal	
Economic	

18. Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.

Feasibility	Impact
Legal	
Economic	

19. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

20. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Safety
	Social

21. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Political/Public
Economic	Safety
	Social

22. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	Impact
Legal	Political/Public

23. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	Impact
Legal	Political/Public
	Social

24. Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the “new” project).

Feasibility	Impact
	Political/Public

25. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).

Feasibility	Impact
Legal	Political/Public
Economic	

26. Legal constraints/concerns that can impede or prevent the transaction/project.

Feasibility	Impact
Legal	

27. Available legal consultants/resources to implement TxDOT’s airspace leasing program.

Feasibility	Impact
Legal	
Economic	

28. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	
Economic	

29. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

30. TxDOT’s exposure in terms of liability and risks.

Feasibility	Impact
Legal	Political/Public
Economic	

31. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Airspace Leasing: Utility

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.

Feasibility	Impact
Technical	Safety
Economic	

4. Interested parties (i.e., potential developers) have been identified or have approached TxDOT.

Feasibility	Impact
Technical	
Economic	

5. Utility is considered private (i.e., will require airspace leasing agreement).

Feasibility	Impact
Legal	Political/Public

6. Project characteristics and potential impacts on traffic, utilities, community, and environment (e.g., water or soil contamination, explosive, and safety concerns) that could impact project/application feasibility.

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

7. Site characteristics (i.e., location, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

8. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

9. Current TxDOT demand/need for utility (e.g., electricity required to power Dynamic Message Signs and/or need for telecommunication signal (e.g., cell phone and internet, or for transmission of data).

Feasibility	Impact
Technical	Political/Public
Economic	Safety
	Social

10. Potential for competing with private sector (e.g., existing private tower near TxDOT property considered for airspace leasing).

Feasibility	Impact
Legal	Political/Public

11. The utility is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).

Feasibility	Impact
Technical	
Economic	

12. Ability to communicate, involve, and share information about the project/application with general public and stakeholders (i.e., transparency and equal opportunity).

Feasibility	Impact
Technical	Political/Public

13. Current value (i.e., market/Real Estate value) of the property

Feasibility	Impact
Technical	Political/Public
Legal	

Economic	

14. Formal procedures/guidelines available to conduct/implement an airspace leasing program (i.e., agreement, design, construction, and maintenance).

Feasibility	Impact
Technical	Political/Public
Legal	

15. Potential impacts on road maintenance plan and operations (e.g., utilities crossing the road, antenna installation, and utility maintenance).

Feasibility	Impact
Technical	Safety
Economic	

16. Anticipated environmental impacts and mitigation measures..

Feasibility	Impact
Legal	Environmental
Economic	Social

17. Potential risk of accidents/unsafe situations (e.g., explosion precaution, electrical discharge/shock, leak detection, valves, clear zone, and accidents).

Feasibility	Impact
Technical	Political/Public
Legal	Environmental
Economic	Safety

18. Construction plan includes measures to avoid/reduce traffic congestion, noise, unsafe situations, accidents, and other negative community impacts.

Feasibility	Impact
Technical	Environmental
Economic	Safety
	Social

19. Required investments in technologies and systems.

Feasibility	Impact
Technical	
Economic	

20. Compliance with FHWA, AASTHO, and other agency requirements.

Feasibility	Impact
Technical	Safety
Legal	
Economic	

21. Permit or license required to execute/construct project.

Feasibility	Impact
Legal	
Economic	

22. FAA and DOD approved and granted permit for the project (i.e., if the project is located within 3-5 miles from a public or military airport, or has tower higher than 200 ft).

Feasibility	Impact
Legal	
Economic	

23. Financial resources of and warranties (i.e., bond approval and surety) provided the project developer.

Feasibility	Impact
Legal	
Economic	

24. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

25. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Safety
	Social

26. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Political/Public
Economic	Safety
	Social

27. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	Impact
Legal	Political/Public

28. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	Impact
Legal	Political/Public
	Social

29. Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	Impact
	Political/Public

30. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale).

Feasibility	Impact
Legal	Political/Public
Economic	

31. Legal constraints/concerns that can impede or prevent the transaction/project.

Feasibility	Impact
Legal	

32. Available legal consultants/resources to implement TxDOT's airspace leasing program.

Feasibility	Impact
Legal	
Economic	

33. Available legal consultants/resources to advise and review transactions and contractual agreements

Feasibility	Impact
Legal	

Economic	

34. Resources required to train or acquire in-house legal resources/counsel

Feasibility	Impact
Legal	
Economic	

35. TxDOT's exposure in terms of liability and risks (e.g., utility relocation).

Feasibility	Impact
Legal	Political/Public
Economic	

36. Investment required by TxDOT to implement the Value Extraction Application

Feasibility	Impact
Economic	Political/Public

Advertising

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Interested parties have been identified or have approached TxDOT.

Feasibility	Impact
Technical	
Economic	

4. Available data/information on traffic exposure (i.e., visibility).

Feasibility	Impact
Technical	

5. Identified and selected advertising mode (e.g., brochures, outdoor advertising, blue signs, live vegetation, or naming rights).

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

6. Project characteristics and potential impacts on traffic, road maintenance, utilities, nearby communities, and the environment.

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

7. Site characteristics (i.e., location, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

8. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

9. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

10. Current value (i.e., market/Real Estate value) of the property.

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

11. Formal procedures/guidelines available to conduct/implement advertising program (e.g., staff, specifications, and agreements).

Feasibility	Impact
Technical	Political/Public
Legal	

12. Anticipated environmental impacts and mitigation measures..

Feasibility	Impact
Legal	Environmental
Economic	Social

13. Potential risk of accidents/unsafe situations (e.g., crash, clear zones, and driver distraction).

Feasibility	Impact
Technical	Safety
Legal	
Economic	

14. Potential educational benefits associated with advertising content (i.e., message and images).

Feasibility	Impact
Legal	Political/Public
	Environmental
	Safety
	Social

15. Required investments in technologies and systems (e.g., electricity, internet, and fiber optics).

Feasibility	Impact
Technical	
Economic	

16. Compliance with FHWA, AASTHO, TxDOT State Rural Act, and other agencies' requirements

Feasibility	Impact
Technical	Safety
Legal	
Economic	

17. Permit or license required to execute/construct project.

Feasibility	Impact
Legal	
Economic	

18. Compliance with Texas Highway Beautification Act (HBA).

Feasibility	Impact
Legal	Political/Public

19. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

20. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Safety
	Social

21. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Political/Public
Economic	Safety
	Social

22. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	Impact
Legal	Political/Public

23. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	Impact
Legal	Political/Public
	Social

24. Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the “new” project).

Feasibility	Impact
	Political/Public

25. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale)

Feasibility	Impact
Legal	Political/Public
Economic	

26. Legal constraints/concerns that can impede or prevent the transaction/project

Feasibility	Impact
Legal	

27. Available legal consultants/resources to implement TxDOT’s advertising program.

Feasibility	Impact
Legal	
Economic	

28. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	
Economic	

29. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

30. TxDOT’s exposure in terms of liability and risks.

Feasibility	Impact
Legal	Political/Public
Economic	

31. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Solar Panels (ROW & Vacant Land)

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.

Feasibility	Impact
Technical	Safety
Economic	

4. Interested parties (i.e., potential developers) have been identified or have approached TxDOT.

Feasibility	Impact
Technical	
Economic	

5. Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.

Feasibility	Impact
Legal	Political/Public
Economic	Environmental

6. Project characteristics and potential impacts on traffic (e.g., driver distraction), community (e.g., property values), and the environment.

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

7. Site characteristics (i.e., location, solar potential, clearances, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

8. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

9. The solar project is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).

Feasibility	Impact
Technical	
Economic	

10. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

11. Access to vendors/solar specialists (e.g., for installation and maintenance).

Feasibility	Impact
Technical	Political/Public
Economic	Social

12. Current TxDOT demand/need for electricity at the project site (e.g., lighting pole and signs).

Feasibility	Impact
Economic	

13. Ability/cost to connect to the grid (e.g., distance from transmission lines).

Feasibility	Impact
Technical	
Economic	

14. Need for backup system for solar project (i.e., battery or on-grid electricity source) to supply TxDOT's electricity needs.

Feasibility	Impact
Technical	Environmental
Economic	Social

15. Available infrastructure (e.g., fiber optic or wireless signal) at site to support and facilitate monitoring and management of the project/output.

Feasibility	Impact
Technical	
Economic	

16. Current value (i.e., market/Real Estate value) of the property.

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

17. Formal procedures/guidelines available to conduct/implement solar energy project (i.e., agreement, design, construction, and maintenance).

Feasibility	Impact
Technical	Political/Public
Legal	

18. Potential impacts of the solar project on road maintenance and operations (e.g., impact of solar panel maintenance).

Feasibility	Impact
Technical	Safety
Economic	

19. Anticipated environmental impacts and mitigation measures.

Feasibility	Impact
Legal	Environmental
Economic	Social

20. Potential risk of accidents/unsafe situations (e.g., accidents, driver distraction, clear zones, guard rails, and adequate access to site).

Feasibility	Impact
Technical	Safety
Legal	

Economic	

21. Compliance with Texas Highway Beautification Act (HBA).

Feasibility	**Impact**
Legal	Political/Public

22. Construction plan includes measures to avoid/reduce traffic congestion, noise, unsafe situations, accidents, and other negative community impacts.

Feasibility	**Impact**
Technical	Environmental
Economic	Safety
	Social

23. Required investments in technologies and systems.

Feasibility	**Impact**
Technical	
Economic	

24. Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.

Feasibility	**Impact**
Technical	Safety
Legal	
Economic	

25. Permit or license required to execute/construct project.

Feasibility	**Impact**
Legal	
Economic	

26. FAA has approved and granted permit for the solar project (i.e., if the project is located within 3-5 miles from a public or military airport).

Feasibility	**Impact**
Legal	
Economic	

27. Net metering applies.

Feasibility	**Impact**
Economic	

28. Federal and State incentives, as well as Renewable Energy Credits (REC) are available.

Feasibility	Impact
Economic	Political/Public

29. Potential concerns about "free access" to TxDOT's property (i.e., facility, land, or ROW) by third party.

Feasibility	Impact
Legal	Political/Public
	Safety

30. Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.

Feasibility	Impact
Legal	
Economic	

31. Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Social

32. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

33. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Safety
	Social

34. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Political/Public
Economic	Safety

	Social

35. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	**Impact**
Legal	Political/Public

36. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	**Impact**
Legal	Political/Public
	Social

37. Anticipated political and public opposition to transaction/project (e.g., controversy and potential impacts triggered by the "new" project)

Feasibility	**Impact**
	Political/Public

38. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.

Feasibility	**Impact**
Legal	Political/Public
Economic	

39. Legal constraints/concerns that can impede or prevent the transaction/project.

Feasibility	**Impact**
Legal	

40. Patents and associated costs that could impact project/application feasibility.

Feasibility	**Impact**
Legal	
Economic	

41. Available legal consultants/resources to implement TxDOT's solar program.

Feasibility	**Impact**
Legal	
Economic	

42. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	**Impact**
Legal	

Economic	

43. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

44. TxDOT's exposure in terms of liability and risks (e.g., solar array relocation or damage).

Feasibility	Impact
Legal	Political/Public
Economic	

45. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Solar Panels (Office & Facilities)

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement .

Feasibility	Impact
Technical	Safety
Economic	

4. Interested parties (i.e., potential developers) have been identified or approached TxDOT.

Feasibility	Impact
Technical	
Economic	

5. Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.

Feasibility	Impact
Legal	Political/Public
Economic	Environmental

6. Site/building characteristics (i.e., location, solar potential, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	
Economic	

7. Building/facility's electrical system has been/can be retrofitted to use solar energy.

Feasibility	Impact
Technical	
Economic	

8. The roof area/external area is large enough to generate sufficient energy to meet the building/facility's energy demand.

Feasibility	Impact
Economic	Environmental

9. The solar project is financially feasible.

Feasibility	Impact
Economic	

10. The solar project is designed and implemented as a component of building/facility (i.e., included in the building/facility design).

Feasibility	Impact
Technical	
Economic	

11. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information)

Feasibility	Impact
Technical	Political/Public

12. Access to vendors/ solar panel specialists (e.g., for installation and maintenance).

Feasibility	Impact
Technical	Political/Public

Economic	Social

13. Current TxDOT demand/need for electricity at the site (e.g., building/facility electricity usage).

Feasibility	**Impact**
Economic	

14. Ability/cost to connect to the grid (e.g., distance from transmission lines).

Feasibility	**Impact**
Technical	
Economic	

15. Need for backup system for solar project (i.e., battery or on-grid electricity source) to supply TxDOT's electricity needs.

Feasibility	**Impact**
Technical	Political/Public
Economic	Environmental

16. Formal procedures/guidelines available to conduct/implement solar energy project (i.e., agreement, design, construction, and maintenance).

Feasibility	**Impact**
Technical	Political/Public
Legal	

17. Anticipated environmental impacts and mitigation measures.

Feasibility	**Impact**
Legal	Environmental
Economic	Social

18. Potential risk of accidents/unsafe situations.

Feasibility	**Impact**
Technical	Safety
Legal	
Economic	

19. Required investments in technologies and systems.

Feasibility	**Impact**
Technical	
Economic	

20. Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.

Feasibility	Impact
Technical	Safety
Legal	
Economic	

21. Permit or license required to execute/construct project.

Feasibility	Impact
Legal	
Economic	

22. FAA has approved and granted permit for the solar project (i.e., if the project is located within 3-5 miles from a public or military airport).

Feasibility	Impact
Legal	
Economic	

23. Net metering applies.

Feasibility	Impact
Economic	

24. Federal and State incentives, as well as Renewable Energy Credits (REC) are available.

Feasibility	Impact
Economic	Political/Public

25. Potential concerns about “free access” to TxDOT’s property (i.e., facility or building) by third party.

Feasibility	Impact
Legal	Political/Public
	Safety

26. Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.

Feasibility	Impact
Legal	
Economic	

27. Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Social

28. Anticipated benefits to TxDOT (e.g., financial, technical, and social).

Feasibility	Impact
Technical	Political/Public
Economic	Social

29. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	Impact
Legal	Political/Public

30. Anticipated political and public opposition to solar project (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	Impact
	Political/Public

31. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.

Feasibility	Impact
Legal	Political/Public
Economic	

32. Legal constraints/concerns that can impede or prevent the transaction/project.

Feasibility	Impact
Legal	

33. Available legal consultants/resources to implement TxDOT solar program.

Feasibility	Impact
Legal	
Economic	

34. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	

Economic	

35. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

36. TxDOT's exposure in terms of liability and risks (e.g., solar array relocation or damage).

Feasibility	Impact
Legal	Political/Public
Economic	

37. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Wind Turbine (ROW & Vacant Land)

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.

Feasibility	Impact
Technical	Safety
Economic	

4. Interested parties (i.e., potential developers) have been identified or have approached TxDOT.

Feasibility	Impact
Technical	
Economic	

5. Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.

Feasibility	Impact
Legal	Political/Public
Economic	Environmental

6. Project characteristics and potential impacts on traffic (e.g., driver distraction) and nearby community (e.g., property value, noise, shade, and tourism).

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

7. Site characteristics (i.e., location, wind potential, clearances, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

8. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

9. The wind project is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).

Feasibility	Impact
Technical	
Economic	

10. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

11. Access to vendors/ wind turbine specialists (e.g., for installation and maintenance).

Feasibility	Impact
Technical	Political/Public
Economic	Social

12. Current TxDOT demand/need for electricity at the project site (e.g., lighting pole and signs).

Feasibility	Impact
Economic	

13. Ability/cost to connect to the grid (e.g., distance from transmission lines).

Feasibility	Impact
Technical	
Economic	

14. Need for backup system for wind project (i.e., battery or on-grid electricity source) to supply TxDOT's electricity needs.

Feasibility	Impact
Technical	Political/Public
Economic	Environmental
	Social

15. Available infrastructure (e.g., fiber optic or wireless signal) at site to support and facilitate monitoring and management of the wind energy project/output.

Feasibility	Impact
Technical	
Economic	

16. Current value (i.e., market/Real Estate value) of the property.

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

17. Formal procedures/guidelines available to conduct/implement wind energy project (i.e., agreement, design, construction, and maintenance).

Feasibility	Impact
Technical	Political/Public
Legal	

18. Potential impacts of the wind project on road maintenance and operations (e.g., impact of wind turbine installation and maintenance)

Feasibility	Impact
Technical	Safety
Economic	

19. Anticipated environmental impacts and mitigation measures.

Feasibility	Impact
Legal	Environmental
Economic	Social

20. Potential risk of accidents/unsafe situations (e.g., accidents, blade failure, fire, blade flickering, oil leaks, snow throw, driver distraction, clear zone, guard rails, and adequate access to site).

Feasibility	Impact
Technical	Environmental
Legal	Safety
Economic	

21. Compliance with Texas Highway Beautification Act (HBA).

Feasibility	Impact
Legal	Political/Public

22. Construction plan includes measures to avoid/reduce traffic congestion, noise, unsafe situations, accidents, and other negative community impacts.

Feasibility	Impact
Technical	Environmental
Economic	Safety
	Social

23. Required investments in technologies and systems.

Feasibility	Impact
Technical	
Economic	

24. Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.

Feasibility	Impact
Technical	Safety
Legal	

Economic	

25. Permit or license required to execute/construct project.

Feasibility	Impact
Legal	
Economic	

26. Potential interference with nearby telecommunication, radar, and/or wireless signals.

Feasibility	Impact
Legal	Political/Public
	Safety
	Social

27. FAA and DOD approved and granted permit for the project (i.e., if the project is located within 3-5 miles from a public or military airport, or the wind turbine is higher than 200 ft)

Feasibility	Impact
Legal	
Economic	

28. Net metering applies.

Feasibility	Impact
Economic	

29. Federal and State incentives, as well as Renewable Energy Credits (REC) are available.

Feasibility	Impact
Economic	Political/Public

30. Potential concerns about "free access" to TxDOT's property (i.e., land or ROW) by third party.

Feasibility	Impact
Legal	Political/Public
	Safety

31. Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.

Feasibility	Impact
Legal	
Economic	

32. Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Social

33. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

34. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Safety
	Social

35. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Political/Public
Economic	Safety
	Social

36. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	Impact
Legal	Political/Public

37. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	Impact
Legal	Political/Public
	Social

38. Anticipated political and public opposition to wind energy project (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	Impact
	Political/Public

39. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.

Feasibility	Impact
Legal	Political/Public
Economic	

40. Legal constraints/concerns that can impede or prevent the transaction/project.

Feasibility	Impact
Legal	

41. Patents and associated costs that could impact project/application feasibility.

Feasibility	Impact
Legal	
Economic	

42. Available legal consultants/resources to implement TxDOT wind program.

Feasibility	Impact
Legal	
Economic	

43. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	
Economic	

44. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

45. TxDOT's exposure in terms of liability and risks (e.g., wind turbine relocation or damage).

Feasibility	Impact
Legal	Political/Public
Economic	

46. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Wind Turbine (Office & Facilities)

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.

Feasibility	Impact
Technical	Safety
Economic	

4. Interested parties (i.e., potential developers) have been identified or approached TxDOT.

Feasibility	Impact
Technical	
Economic	

5. Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.

Feasibility	Impact
Legal	Political/Public
Economic	Environmental

6. Project characteristics and potential impacts on traffic (e.g., driver distraction) and nearby community (e.g., property value, noise, shade, and tourism) that could impact project/application feasibility.

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

7. Site/building characteristics for implementation of the wind system project (i.e., location, wind potential, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	
Economic	

8. Building/facility's electrical system has been/can be retrofitted to use wind system.

Feasibility	Impact
Technical	
Economic	

9. The roof area/external area is large enough to generate sufficient energy to meet the building/facility's energy demand.

Feasibility	Impact
Economic	Environmental

10. The wind project is financially feasible.

Feasibility	Impact
Economic	

11. The wind project is designed and implemented as a component of building/facility (i.e., included in the building/facility design).

Feasibility	Impact
Technical	
Economic	

12. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

13. Access to vendors/ wind turbine specialists (e.g., for installation and maintenance).

Feasibility	Impact
Technical	Political/Public
Economic	Social

14. Current TxDOT demand/need for electricity at the site (e.g., building/facility electricity usage).

Feasibility	**Impact**
Economic	

15. Ability/cost to connect to the grid (e.g., distance from transmission lines).

Feasibility	**Impact**
Technical	
Economic	

16. Need for backup system for wind project (i.e., battery or on-grid electricity source) to supply TxDOT's electricity needs.

Feasibility	**Impact**
Technical	Political/Public
Economic	Environmental
	Social

17. Formal procedures/guidelines available to conduct/implement wind energy project (i.e., agreement, design, construction, and maintenance).

Feasibility	**Impact**
Technical	Political/Public
Legal	

18. Anticipated environmental impacts and mitigation measures.

Feasibility	**Impact**
Legal	Environmental
Economic	Social

19. Potential risk of accidents/unsafe situations (e.g., accident, electrical shock, blade failure, fire, blade flickering, oil leak, and snow throw).

Feasibility	**Impact**
Technical	Safety
Legal	
Economic	

20. Required investments in technologies and systems.

Feasibility	**Impact**
Technical	
Economic	

21. Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.

Feasibility	Impact
Technical	Safety
Legal	
Economic	

22. Permit or license required to execute/construct project.

Feasibility	Impact
Legal	
Economic	

23. Potential interference with nearby telecommunication, radar, and/or wireless signal.

Feasibility	Impact
Legal	Political/Public
	Safety
	Social

24. FAA and DOD approved and granted permit for the project (i.e., if the project is located within 3-5 miles from a public or military airport, or the wind turbine is higher than 200 ft).

Feasibility	Impact
Legal	
Economic	

25. Net metering applies.

Feasibility	Impact
Economic	

26. Federal and State incentives, as well as Renewable Energy Credits (REC) are available.

Feasibility	Impact
Economic	Political/Public

27. Potential concerns about "free access" to TxDOT's property (i.e., office and facility) by third party.

Feasibility	Impact
Legal	Political/Public
	Safety

28. Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.

Feasibility	Impact
Legal	
Economic	

29. Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Social

30. Anticipated benefits to TxDOT (e.g., financial, technical, and social).

Feasibility	Impact
Technical	Political/Public
Economic	Social

31. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	Impact
Legal	Political/Public

32. Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	Impact
	Political/Public

33. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.

Feasibility	Impact
Legal	Political/Public
Economic	

34. Legal constraints/concerns that can impede or prevent the transaction/project.

Feasibility	Impact
Legal	

35. Available legal consultants/resources to implement TxDOT wind program.

Feasibility	Impact
Legal	
Economic	

36. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	
Economic	

37. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

38. TxDOT's exposure in terms of liability and risks (e.g., wind turbine relocation or damage).

Feasibility	Impact
Legal	Political/Public
Economic	

39. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Geothermal Energy

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement .

Feasibility	Impact
Technical	Safety
Economic	

4. Interested parties (i.e., potential developers) have been identified or have approached TxDOT.

Feasibility	Impact
Technical	
Economic	

5. Project/application will assist TxDOT in meeting renewable energy consumption and carbon emissions goals.

Feasibility	Impact
Legal	Political/Public
Economic	Environmental

6. Project characteristics and potential impacts on traffic (e.g., driver distraction) and nearby community (e.g., property value, noise, steam, water disposal, and aquifer).

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

7. Site characteristics (i.e., location, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

8. Quality of the underground resource (i.e., temperature, depth, water, ease to drill) is coherent with the intended application (i.e., direct use of hot water, geothermal heat pump, pavement de-icing, and electricity generation).

Feasibility	Impact
Technical	
Economic	

9. The roof and/or external area is large enough to install the geothermal energy system (i.e., power plant and/or geothermal heat pump) demanded in the building/facility or to generate sufficient energy to the building/facility's energy demand.

Feasibility	Impact
Technical	Environmental
Economic	

10. The geothermal project is financially feasible.

Feasibility	Impact
Economic	

11. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

12. The geothermal energy is designed and implemented as a component together with a new highway or building project (i.e., already included in the highway or building design).

Feasibility	Impact
Technical	
Economic	

13. Building/facility's electrical and/or HVAC systems have been/can be retrofitted to use geothermal energy (i.e., power plant and/or geothermal heat pump).

Feasibility	Impact
Technical	
Economic	

14. Ability to communicate, involve, and share information about the project/application with general public and stakeholders (i.e., transparency and equal opportunity).

Feasibility	Impact
Technical	Political/Public

15. Access to vendors/ geothermal energy specialists (e.g., for installation and maintenance).

Feasibility	Impact
Technical	Political/Public
Economic	Social

16. Current TxDOT demand/need for electricity at the project site (e.g., lighting pole and signs).

Feasibility	Impact
Economic	

17. Ability/cost to connect to the grid (e.g., distance from transmission lines).

Feasibility	Impact
Technical	
Economic	

18. Available infrastructure (e.g., fiber optic or wireless signal) at site to support and facilitate monitoring and management of the project/output.

Feasibility	Impact
Technical	
Economic	

19. Current value (i.e., market/Real Estate value) of the property.

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

20. Formal procedures/guidelines available to conduct/implement geothermal energy project (i.e., agreement, design, construction, and maintenance).

Feasibility	Impact
Technical	Political/Public
Legal	

21. Potential impacts of the geothermal project on road maintenance and operations (e.g., impact of geothermal system installation and maintenance).

Feasibility	Impact
Technical	Safety
Economic	

22. Anticipated environmental impacts and mitigation measures.

Feasibility	Impact
Legal	Environmental
Economic	Social

23. Potential risk of accidents/unsafe situations (e.g., steam, water, icing, snow, roadside erosion, explosion, fire, pavement failure, clear zones, and guard rails).

Feasibility	Impact
Technical	Environmental
Legal	Safety
Economic	

24. Compliance with Texas Highway Beautification Act (HBA).

Feasibility	Impact
Legal	Political/Public

25. Construction plan includes measures to avoid/reduce traffic congestion, noise, unsafe situations, accidents, and other negative community impacts.

Feasibility	Impact
Technical	Environmental
Economic	Safety
	Social

26. Required investments in technologies and systems.

Feasibility	Impact
Technical	
Economic	

27. Compliance with FHWA, AASTHO, National Electrical Code, Fire Protection Association, and other agency requirements.

Feasibility	Impact
Technical	Safety
Legal	
Economic	

28. Permit or license required to execute/construct project, including use of underground resources.

Feasibility	Impact
Legal	
Economic	

29. FAA has approved and granted permit for the project (i.e., if the project is located within 3-5 miles from a public or military airport).

Feasibility	Impact
Legal	
Economic	

30. Net metering applies.

Feasibility	Impact
Economic	

31. Federal and State incentives, as well as Renewable Energy Credits (REC) are available.

Feasibility	Impact
Economic	Political/Public

32. Potential concerns about "free access" to TxDOT's property (i.e., facility, land, or ROW) by third party.

Feasibility	Impact
Legal	Political/Public
	Safety

33. Financial resources of and warranties (i.e., bond approval and surety) provided by the project developer.

Feasibility	Impact
Legal	
Economic	

34. Potential for adopting a value-based procurement strategy (e.g., include considerations beyond project cost, such as social benefits and environmental impacts).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Social

35. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

36. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Social

37. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Safety
Economic	

38. Potential concerns anticipated by General Land Office (GLO) or another public agency (e.g., FHWA, DOE, and DOD).

Feasibility	Impact
Legal	Political/Public

39. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	Impact
Legal	Political/Public
	Social

40. Anticipated political and public opposition to transaction (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	Impact
	Political/Public

41. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.

Feasibility	Impact
Legal	Political/Public
Economic	

42. Legal constraints/concerns that can impede or prevent the transaction/project, including ownership over underground resources.

Feasibility	Impact
Legal	

43. Patents and associated costs that could impact project/application feasibility.

Feasibility	Impact
Legal	
Economic	

44. Available legal consultants/resources to implement TxDOT's geothermal energy program.

Feasibility	Impact
Legal	
Economic	

45. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	

Economic	

46. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

47. TxDOT's exposure in terms of liability and risks (e.g., geothermal system relocation or damage).

Feasibility	Impact
Legal	Political/Public
Economic	

48. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Carbon Sequestration

1. Trained in-house or consultant staff to analyze the project, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement .

Feasibility	Impact
Technical	Safety
Economic	

4. Available in-house or consultant carbon sequestration experts (i.e., carbon verifier and carbon aggregator) to participate in the implementation.

Feasibility	Impact
Technical	
Economic	

5. Project/application will assist TxDOT in meeting carbon emission goals.

Feasibility	Impact
Legal	Political/Public
Economic	Environmental

6. Project characteristics and potential impacts on traffic, utilities, community, and environment (e.g., drainage).

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

7. Site characteristics (i.e., location, soil quality, average rainfall, visibility, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

8. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

9. The carbon sequestration program is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).

Feasibility	Impact
Technical	
Economic	

10. Anticipated potential of sequestrating carbon from the existing/native vegetation.

Feasibility	Impact
Technical	Environment
Economic	

11. Current carbon sequestration baseline at the site has been established.

Feasibility	Impact
Technical	
Economic	

12. Amount of "additional carbon" that is expected to potentially be sequestrated with the carbon sequestration program.

Feasibility	Impact
Economic	Environment

13. Available carbon sequestration protocol for the vegetation envisioned to be used.

Feasibility	Impact
Technical	

14. Carbon market (i.e., formal or informal) to trade or sell carbon credits and current carbon price (i.e., flotation) have been identified.

Feasibility	Impact
Technical	
Economic	

15. Ability to communicate, involve, and share information about the project/application with general public and stakeholders (i.e., transparency).

Feasibility	Impact
Technical	Political/Public

16. Formal procedures/guidelines available to conduct/implement TxDOT's carbon sequestration program (i.e., agreement, trade, and vegetation).

Feasibility	Impact
Technical	Political/Public
Legal	

17. Potential impacts of the carbon sequestration project on road maintenance and operations.

Feasibility	Impact
Technical	Safety
Economic	

18. Anticipated environmental impacts and mitigation measures.

Feasibility	Impact
Legal	Environmental
Economic	Social

19. Potential risk of accidents/unsafe situations (e.g., safety zone, animal attraction, roadside erosion, runoff water, and guard rails).

Feasibility	Impact
Technical	Environmental
Legal	Safety
Economic	

20. Compliance with Texas Highway Beautification Act (HBA).

Feasibility	Impact
Legal	Political/Public

21. Current State programs (HBA, Wildflower, and Green Ribbon projects) and existing obligations to plant along the highways (i.e., that could be used to receive carbon credits) .

Feasibility	Impact
Legal	Political/Public
Economic	

22. Compliance with FHWA, AASTHO, and other agency requirements.

Feasibility	Impact
Technical	Safety
Legal	
Economic	

23. Federal and State incentives, as well as Renewable Energy Credits (REC) are available.

Feasibility	Impact
Economic	Political/Public

24. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

25. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Social

26. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Safety
Economic	

27. Potential concerns anticipated by the General Land Office (GLO) or another public agency (e.g., FHWA, DOE, DOD, and utility company).

Feasibility	Impact
Legal	Political/Public

28. Potential conflict with zoning law, city's master plan, and transportation's plan

Feasibility	Impact
Legal	Political/Public
	Social

29. Anticipated political and public opposition to carbon sequestration project (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	Impact
	Political/Public

30. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.

Feasibility	Impact
Legal	Political/Public
Economic	

31. Legal constraints/concerns that can impede or prevent the transaction/project, including participation in carbon market and ownership over carbon credits.

Feasibility	Impact
Legal	

32. Available legal consultants/resources to implement TxDOT carbon sequestration program.

Feasibility	Impact
Legal	
Economic	

33. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	
Economic	

34. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

35. TxDOT's exposure in terms of liability and risks (e.g., damage on vegetation).

Feasibility	Impact
Legal	Political/Public
Economic	

36. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Biomass & Biofuel

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement .

Feasibility	Impact
Technical	Safety
Economic	

4. Interested parties (i.e., farmers or private companies) have been identified or approached TxDOT.

Feasibility	Impact
Technical	
Economic	

5. Available in-house or consultant biomass & biofuel specialists (e.g., agronomist).

Feasibility	Impact
Technical	
Economic	

6. Project/application will assist TxDOT in meeting renewable energy and carbon emission goals.

Feasibility	Impact
Legal	Political/Public
Economic	Environmental

7. Project characteristics and potential impacts on traffic, utilities, community, and environment (e.g., drainage and property value).

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

8. Site characteristics (i.e., location, soil quality and compaction, average rainfall, ease to mow, logistics, clearances, visibility, access, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

9. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

10. The biomass & biofuel program is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).

Feasibility	Impact
Technical	
Economic	

11. Needs for fertilize, herbicide, and/or irrigation.

Feasibility	Impact
Technical	Political/Public
Economic	Environmental

12. Potential yield and biofuel production capacity of the crop/vegetation.

Feasibility	Impact
Technical	
Economic	

13. Available biomass & biofuel market to trade or process biomass (e.g., biorefinery).

Feasibility	Impact
Technical	
Economic	

14. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

15. Current value (i.e., market/Real Estate value) of the property.

Feasibility	Impact
Technical	Political/Public
Legal	
Economic	

16. Formal procedures/guidelines available to conduct/implement TxDOT's biomass & biofuel program (i.e., agreement, trade, biofuel refine, and farming procedures).

Feasibility	Impact
Technical	Political/Public
Legal	

17. Potential impacts of biomass & biofuel program on road maintenance and operations (e.g., impacts of planting, harvesting, and transporting biomass).

Feasibility	**Impact**
Technical	Safety
Economic	

18. Anticipated environmental impacts and mitigation measures.

Feasibility	**Impact**
Legal	Environmental
Economic	Social

19. Potential risk of accidents/unsafe situations (e.g., safety zone, machinery access, animal attraction, roadside erosion, runoff water, and guard rails).

Feasibility	**Impact**
Technical	Environmental
Legal	Safety
Economic	

20. Compliance with Texas Highway Beautification Act (HBA) and Wildflower program.

Feasibility	**Impact**
Legal	Political/Public

21. Current State programs (HBA, Wildflower, and Green Ribbon projects) and existing obligations to plant along the highways (i.e., that could be used to extract biomass & biofuel).

Feasibility	**Impact**
Legal	Political/Public
Economic	

22. Existing training requirements (i.e., safety) and traffic control plan to staff and third parties involved in planting and harvesting.

Feasibility	**Impact**
Technical	Safety
Economic	

23. Compliance with FHWA, AASTHO, and other agency requirements.

Feasibility	**Impact**
Technical	Safety
Legal	
Economic	

24. Permit or license required to execute/construct project (e.g., agricultural activities on public land).

Feasibility	Impact
Legal	
Economic	

25. Federal and State incentives, as well as Renewable Energy Credits (REC) are available.

Feasibility	Impact
Economic	Political/Public

26. Potential concerns about "free access" to TxDOT's property (i.e., land and ROW) by third party.

Feasibility	Impact
Legal	Political/Public
	Safety

27. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	Impact
Economic	Political/Public
	Social

28. Anticipated benefits to the region or state (e.g., increase local or state taxes).

Feasibility	Impact
Economic	Political/Public
	Environmental
	Social

29. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	Impact
Technical	Safety
Economic	

30. Potential concerns anticipated by the General Land Office (GLO) or another public agency (e.g., FHWA, DOE, DOD, and utility company).

Feasibility	Impact
Legal	Political/Public

31. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	Impact
Legal	Political/Public

	Social

32. Anticipated political and public opposition to biomass & biofuel project (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	**Impact**
	Political/Public

33. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), as well as incentives and REC ownership.

Feasibility	**Impact**
Legal	Political/Public
Economic	

34. Legal constraints/concerns that can impede or prevent the transaction/project, including ownership over biomass harvested.

Feasibility	**Impact**
Legal	

35. Patents and associated costs that could impact project/application feasibility.

Feasibility	**Impact**
Legal	
Economic	

36. Available legal consultants/resources to implement TxDOT biomass & biofuel program.

Feasibility	**Impact**
Legal	
Economic	

37. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	**Impact**
Legal	
Economic	

38. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	**Impact**
Economic	Political/Public

39. TxDOT's exposure in terms of liability and risks (e.g., damage on plantation).

Feasibility	**Impact**
Legal	Political/Public

Economic	

40. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Wildlife Crossing

1. Trained in-house or consultant staff to analyze the project, specifications, and potential impacts, and challenges.

Feasibility	Impact
Technical	
Economic	

2. In-house staff member to champion the evaluation and implementation of the Value Extraction Application.

Feasibility	Impact
Technical	
Economic	

3. Available in-house or consultant safety and security experts to conduct safety assessment, advise the design, and provide insight in the drafting of the concept and leasing agreement.

Feasibility	Impact
Technical	Safety
Economic	

4. Available in-house staff to specify and oversee design and construction of the project.

Feasibility	Impact
Technical	
Economic	

5. Available in-house or consultant wildlife crossing experts to conduct and advise design concept.

Feasibility	Impact
Technical	
Economic	

6. Target species (e.g., deer, reptiles, and small mammals) have been identified.

Feasibility	Impact
Technical	

7. Available data/information on animal migratory routes and movement (i.e., hot spot location).

Feasibility	Impact
Technical	

8. Project characteristics and potential impacts on traffic and community (e.g., habitat integration and wildlife preservation).

Feasibility	Impact
Technical	Political/Public
	Environmental
	Safety
	Social

9. Site characteristics (i.e., location, clearances, visibility, and infrastructure) that could impact project/application feasibility.

Feasibility	Impact
Technical	Environmental
Economic	Safety

10. Anticipated future highway system needs (i.e., traffic volume, lanes, and clearances) that could require future road expansion.

Feasibility	Impact
Technical	Social
Legal	
Economic	

11. Frequency of occurrence of fatal accidents resulted from vehicle-animal-crash at the site and potential reduction with the wildlife crossing project.

Feasibility	Impact
Legal	Political/Public
Economic	Safety

12. The wildlife crossing project is designed and implemented as a component together with a new highway project (i.e., already included in the highway design).

Feasibility	Impact
Technical	
Economic	

13. Available infrastructure (e.g., fiber optic and wireless signal) at the site to support and facilitate monitoring and management of effectiveness and use of the wildlife crossing project.

Feasibility	Impact
Technical	
Economic	

14. Ability to communicate, involve, and share information with general public and stakeholders about the Value Extraction Application project (i.e., transparency and equal access to information).

Feasibility	Impact
Technical	Political/Public

15. Formal procedures/guidelines available to conduct/implement TxDOT's wildlife crossing program (i.e., agreement, design, construction, and maintenance).

Feasibility	Impact
Technical	Political/Public
Legal	

16. Potential impacts of the wildlife crossing project on road maintenance and operations.

Feasibility	Impact
Technical	Safety
Economic	

17. Anticipated environmental impacts and mitigation measures.

Feasibility	Impact
Legal	Environmental
Economic	Social

18. Potential risk of accidents/unsafe situations (e.g., clear zone, clear sight, lighting, signs, traffic control, access, fence, and guard rail, as well as during construction) and mitigation measurements.

Feasibility	Impact
Technical	Safety
Legal	
Economic	

19. Existing training requirements (i.e., safety) and traffic control plan to staff and third parties involved in the construction of the wildlife crossing.

Feasibility	Impact
Technical	Safety

Economic	

20. Compliance with FHWA, AASTHO, and other agency requirements.

Feasibility	**Impact**
Technical	Safety
Legal	
Economic	

21. Permit or license required to execute/construct project.

Feasibility	**Impact**
Legal	
Economic	

22. Federal and State funds and/or incentives for wildlife crossing projects are available.

Feasibility	**Impact**
Economic	Political/Public

23. Anticipated sponsors for wildlife crossing projects (e.g., ONGs and insurance companies).

Feasibility	**Impact**
Legal	Political/Public
Economic	

24. Anticipated car insurance cost reduction.   .

Feasibility	**Impact**
Economic	Political/Public
	Social

25. Anticipated direct and indirect jobs created and economic development impacts resulting from the project.

Feasibility	**Impact**
Economic	Political/Public
	Social

26. Anticipated benefits to TxDOT (e.g., financial, technical, and safety).

Feasibility	**Impact**
Technical	Political/Public
Economic	Safety

27. Potential concerns anticipated by the General Land Office (GLO) or another public agency (e.g., FHWA, DOE, DOD, and utility company).

Feasibility	Impact
Legal	Political/Public

28. Potential conflict with zoning law, city's master plan, and transportation's plan.

Feasibility	Impact
Legal	Political/Public
	Social

29. Anticipated political and public opposition to wildlife crossing project (e.g., controversy and potential impacts triggered by the "new" project).

Feasibility	Impact
	Political/Public

30. Potential risks and implications associated with considered business model (e.g., private-public-partnership, lease, easement, and sale), including incentives, sponsorship, and donation.

Feasibility	Impact
Legal	Political/Public
Economic	

31. Legal constraints/concerns that can impede or prevent the transaction/project.

Feasibility	Impact
Legal	

32. Available legal consultants/resources to implement TxDOT's wildlife crossing program.

Feasibility	Impact
Legal	
Economic	

33. Available legal consultants/resources to advise and review transactions and contractual agreements.

Feasibility	Impact
Legal	
Economic	

34. Resources required to train or acquire in-house legal resources/counsel.

Feasibility	Impact
Economic	Political/Public

35. TxDOT's exposure in terms of liability and risks (i.e., during construction and after completion).

Feasibility	Impact
Legal	Political/Public
Economic	

36. Investment required by TxDOT to implement the Value Extraction Application.

Feasibility	Impact
Economic	Political/Public

Appendix VI: Summary of Best Practices and Pilot Projects

Property Management

The California Department of Transportation (Caltrans) is the best example of how to implement a robust, efficient, and successful property management program. Caltrans' property management program revolves around a well-developed and comprehensive website that contains detailed information regarding auction procedures, leasing guidelines, and property announcements. Currently, Caltrans has about 12 managers and 48 employees in 12 districts involved in property management; the staff is not dedicated 100% to the program. In summary, the property management program is divided into three value extraction functions: airspace and ROW leasing, property management, and excess land sales. The airspace leasing component generated about $25 million in FY 2009 with the leasing of airspace beneath viaducts for parking lots, leasing airspace over freeways, and leasing rights-of-way (ROW) for telecommunication antennas. The property management division has secured about $12 million in revenue per year, mostly from the leasing of property in two significant corridors owned by Caltrans. Finally, the excess land component is responsible for lands or properties that are not needed or will not be used within 20 years and secured nearly $11.5 million in revenue that came from selling 290 parcels.

Property Management (Rest Area)

The Interstate Oasis program was launched in 2006 by the FHWA to overcome the problem of a lack of rest areas and the barriers to rest area privatization, as well as to reduce the financial and administrative costs of the State DOTs. Interstate Oasis program is a public-private partnership defined by the FHWA as an off-freeway facility that aims to supplement the public rest area. To qualify as an Interstate Oasis, the facility has to comply with a list of requirements and specifications, including a standardized design, offering of products and services to the public, 24-hour access to restrooms, and parking for autos and heavy trucks. Furthermore, a specific and unique logo has to be adopted to identify the units that are part of the program.

Another important example of how to extract value from rest areas is presented by the Oases complex in Illinois. The complex comprises seven private and commercialized rest areas that are located on the I-294/94, I-90, and I-88 tollways and offers several services, such as gas station, car wash, food court, shopping, and ATM.

Airspace Leasing (Building)

In Boston, the airspace over the Massachusetts Turnpike holds at least three formalized airspace leasing agreements for buildings, all of which have been topics of research (Figure VI.1). The first is the Copley Place, a 3.5 million square-feet complex constructed in 1986 that comprises hotel, retail store, office, parking, and housing. The second in Columbus Center, a complex of buildings that occupies 7 acres divided into 4 parcels of air rights and totals 1.4 million square-feet of construction. The Columbus Center consists of hotel, restaurant, retail store, health club, residential building, and parking. Finally, the One Kenmore occupies one parcel of airspace and is still in development. When concluded, the One Kenmore will have 1.2 million square-feet of construction, including office, health club, grocery store, community center, and parking. The economic feasibility of all three projects was ensured by an airspace premium funding granted by the City of Boston. This fund was needed because the land value in Boston in the outset of the projects was not yet high to spark and encourage private investment. In terms of benefits, the City of Boston could reconnect the neighbors that have been divided by the highway corridor, generate new tax revenue, and create permanent jobs with the economic development.

Source: Savvides (2005)

Figure VI.1: Boston Airspace Program

Airspace Leasing (Parking lot)

Caltrans has extensively used airspace leasing for parking lots as a VEA. Caltrans has entered into both long-term and short-term leasing agreement for parking. In general, the private sector has approached Caltrans to lease available spaces. Some parking lot structures are, however, leased to parking companies via a competitive bid for 2 or 3 years. To announce the bidding process, Caltrans employs frameworks such as Craigslist and email. In addition, park-and-ride lots usually somewhat distant from downtown areas are typically leased to independent car sellers or for community events on weekends, for example. These park-and-ride leases usually involve community centers that are responsible for providing security and cleaning the area. The community centers, typically, pay a lower rate for leasing the park-and-ride lot. Caltrans currently has around 400 parking lot leasing agreements that generate a reasonable level of income.

Texas has some examples of parking lots beneath TxDOT highways. However, TxDOT comments that the agreement typically involves other public agencies (e.g., city, court house, and DPS) and does not include any financial payment or benefit.

Airspace Leasing (Utilities)

In 1999, the Florida DOT "reached a 30-year lease agreement with Lodestar Towers, Inc., allowing Lodestar Towers, Inc. to lease access to the Department's limited access ROW in return for compensation formulated as a percentage of the gross revenues received from renting antenna space to commercial wireless service providers." The public-private lease agreement was developed in compliance with the Department's Telecommunications Policy, whose goal is "to consolidate wireless tower use to the Department's limited access ROW by providing equal access and opportunity to all wireless service providers. This strategy encourages wireless service providers to collocate on towers located on the Department's limited access ROW instead of developing numerous new tower sites in local communities. The resulting reduction of the number of towers and the location of needed towers as far from residential areas as possible facilitates the intent of the lease to support the wireless service providers while minimizing wireless tower proliferation." "To date, Lodestar Towers, Inc. has constructed 26 towers on the Department's ROW. Another 22 proposed towers are under siting and design review by the Department" (Florida ITS, 2001). See Figure VI.2.

Caltrans received $7.3 million in revenue in FY 2008 from its airspace leasing program, of which $1.3 million came from 52 cell towers (Caltrans, 2009). Caltrans's Leasing Program Administration personnel regard the cost-effectiveness of cell towers to be a major benefit. Cell towers do not require extensive maintenance on the sites and generate reasonable revenues (Caltrans, 2009). Caltrans's Airspace program for telecommunications is administrated by an agent and five-person team that are responsible for managing the relationship with renters, seeking business opportunities, and implementing the procedures needed for leasing (Caltrans, 2009). Most of the airspace leasing agreements involve telecommunication providers, which encompass 20 different companies. Most of the telecommunication leasing agreements are located in urban areas (about 90%) and all of them are in accordance with the Caltrans's master license agreement that grants a 5-year license for a specific site, with the option to renew the license five times for 5 years each.

Source: Florida ITS (2001)

Figure VI.2: Antenna Tower

In Texas, TxDOT estimates receiving between $2 million to $4 million from an informal and inactive program. TxDOT also believes that formalizing this program could bring more management efficiency and incomes to the state.

Advertising

In Washington, rest areas are equipped with brochure dispensers that are rented to vendors and companies. The vendor can rent dispenser space at a rest area or at several rest areas (i.e., packages). The rent price varies depending on the number of rest areas in the rent package and/or the size of the panel.

Another interesting application of this VEA is found in Toronto, Canada, where the vegetation along the highway that links the international airport to downtown is used to advertise companies.

Blue signs (or logo signs) are definitely the most common advertising type encountered throughout the U.S. highway system, used mainly to inform travelers about services along the road.

Naming rights are also a very popular advertising program used by the private sector that has been adopted by the public sector in certain circumstances, such as train stations, airports, toll booths, rest areas, and highway corridors. In this arrangement, a private company pays a naming right fee in exchanging for having its company name and/or logo associated with the property.

In general, two nationwide programs provide opportunities concerning sponsorship for littering removal and roadside maintenance: the Adopt A Highway Maintenance Corporation (AHMC) and the Adopt A Highway—Litter Removal Service of America (AAH-LRSA). AHMC and AAH-LRSA provide the opportunity to brand a private company name and logo while supporting the community that potential customers live and work in. Companies that make a commitment to finance litter pickup along a stretch of highway receive a sign that identifies them as a community-minded, environmentally conscious business.

Another sort of sponsorship that can be used by TxDOT to fund certain VEA projects (i.e., renewable energy projects) is called Adopt-A-Watt. Like Adopt-a-Highway, in an Adopt-a-Watt agreement, companies can sponsor or fund clean energy and alternative fuel projects in exchange for having their name advertised and acknowledged. Also, a sign template that complies with FHWA Acknowledgment Sign Standards is provided. The two most popular programs are Sponsor-able Photo-Voltaic Light (SPVL) and Sponsor-able Photo-Voltaic Display (SPVD). In the case of solar lights, the sponsorship fees start at $2,000 per year, while for solar arrays the sponsorship fees start at $11,000 with a 3-year minimum commitment in both cases.

Solar Panel (ROW and Vacant Land)

The Oregon DOT (ODOT) is the pioneer in implementing solar panels in highway ROW. In December 2008, ODOT concluded the installation of the first solar arrays project at the interchange of IH 5 (see Figure 5.8). The arrays can produce up to 117 KWh annually, i.e., one-third of the energy needed on the site. Basically, the solar arrays feed the grid with the electricity produced during the day whereas at night the grid supplies the electricity for interchange lighting.

Currently, SMUD Sacramento (California) is exploring a 594 solar panels project. Also, Caltrans is analyzing the feasibility of installing solar charge stations for electrical vehicles along highways, as well as the installation of solar panels for light poles.

In 2010 the Ohio DOT, in conjunction with the University of Toledo, installed a 100KW solar array—composed by 966 rigid solar panels and 198 flexible solar panels—in the ROW off IH 280 and Greenbelt Parkway in Toledo, OH. The solar array provides all the electricity demanded at the Veteran's Glass City Skyway Bridge, which has a 196-foot lighted pylon containing 384 light emitting diode fixtures

A number of solar projects can be found in European and Oceania transportation ROW. Germany, for example, has invested €11 million in a solar panel project on top of a tunnel on highway A3 that has a 2.8 MW capacity. It is expected that the investment cost will be recovered in 16 years from cost savings. The 16,000 solar modules occupy 2.7 km and will provide electricity to nearly 600 houses. In Australia and some European countries, solar panels have a "dual use." Besides energy generation, the panels also act as sound barriers. See Figures VI.3 through VI.6.

Source: Volpe Center (2011)

Figure VI.3: Solar Panel in Sacramento, CA

Source: Volpe Center (2011

Figure VI.4: Solar Roadside Barrier

Source: Volpe Center (2011

Figure VI.5: Flexible Solar Panels

Source: Volpe Center (2011

Figure VI.6: Solar-Sound Barrier

Solar Panel (Building and Rest Area)

The Wyoming DOT has 19 rest areas that use solar power to provide an estimated half of the rest areas' energy needs. To bring more attention and curiosity about renewable energy and GHG emission reduction, Wyoming DOT installed solar "flowers" at a rest area on Interstate 70 near Parachute in August 2011. In this case, the solar panels have also an aesthetic function and educational purpose.

In Texas, solar panels will be installed at two new rest areas along IH 20.

Figure VI.7 depicts the use of solar panels on a roof top.

Source: Green Solar (2010)

Figure VI.7: Solar Roof

Wind Turbine (ROW and Vacant Land)

Although wind turbines along highway ROW are becoming increasingly common in Europe (e.g., Denmark, Germany, and the Netherlands), in the U.S. this VEA has not received great attention from the DOTs. One of the few examples can be found in Massachusetts, where a 400-foot-tall wind turbine with the potential to generate 1.5 MW has been considered for installation in the middle of a 68-acre site, reaching around 1,500 ft of setback from the highway. This device is expected to generate 3,000 MWh of electricity per year, enough to supply the energy need of nearly 400 households. The land holding is adjacent to the Blandford service area.

The Ohio DOT is installing a small 32KW wind turbine at a maintenance facility in Northwood, adjacent to highway ROW along IH 68. The wind turbine is approximately 100 feet tall and is located 140 feet from the roadway (i.e., setback). The wind system proposed is intended to provide up to 65% of the electricity consumed by the facility.

TAK Studio envisioned light poles connected with wind turbines that would harvest the traffic turbulence and convert into electricity to supply the energy needed to illuminate the highways. The Israel National Roads Company is conducting the feasibility studies (i.e., front-end planning) to install small wind turbines tied in lighting poles along the coastal road, taking advantage of sea winds. In Tawain, small wind turbines are being incorporated with parking lots.

The Colorado DOT (CDOT), Ohio DOT, MassDOT, and Illinois DOT have worked with local consulting companies and/or universities to identify opportunity zones and sites suitable for renewable energy and revenue-generating projects on highway ROW, rest areas, and weigh stations. Sites were identified by overlaying ROW maps and GIS data layers with maps of potential renewable energy sources (i.e., solar, wind, geothermal, and biomass resource maps).

Source: NY-Attraction (2011)

Figure VI.8: Wind Turbine

Source: Dreamstime (2011)

Figure VI.9: Wind farm along a highway

Wind Turbine (Building and Rest Area)

A number of examples exist where wind turbines have been installed at rest areas and buildings to provide energy and promote renewable energy generation. A wind turbine project is also currently being explored at the Blandford rest area on the Massachusetts Turnpike. A 400-foot-tall wind turbine with the potential to generate 1.5 MW is being considered. This device is expected to generate 3,000 MWh of electricity per year, enough to supply the energy need of nearly 400 households.

The Ohio DOT (ODOT) is installing a small 32KW wind turbine at a maintenance facility in Northwood, adjacent to highway ROW along IH 68. The wind turbine is approximately 100 feet tall and is located 140 feet from the roadway (i.e., setback). The wind system proposed is intended to provide up to 65% of the electricity consumed by the facility

In Texas, two 50 KWh wind turbines have been installed at two rest areas: on IH 40 close to Amarillo and close to Lubbock. Figures VI.10 through VI.12 show examples of wind turbines.

Source: WindEnergy7 (2008)

Figure VI.10: Small Wind Turbine

Source: BBC (2005)

Figure VI.11: Small Wind Turbine

Source: Hemphill (2009)

Figure VI.12: Wind Turbine on a facility

Geothermal Energy

The geothermal heat pump (GHP) is widely and commonly used in offices and residences to reduce energy consumption from HVAC systems. The size and complexity of GHP systems depends on the use of HVAC system and how much electricity is intended to be saved.

Geothermal systems—similar to GHP—have been applied as a de-icing mechanism on highways since late 1940s. In this system, "heat pipes" are embedded in the pavement, where snow or ice layers have been constantly critical. Recent observations estimate that geothermal systems could keep the pavement free of snow and ice at temperatures as low as -10^{o}F (-23^{o}C). Several DOTs (New Jersey, South Dakota, Wyoming, and Virginia) have adopted geothermal systems in very specific locations, as have countries such as Japan, Switzerland, and Argentina.

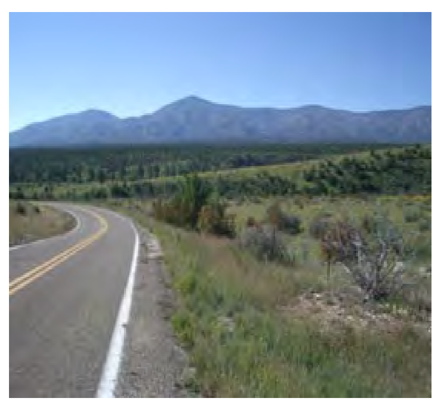
Ultimately, a broader approach has been undertaken by CDOT, Ohio DOT, MassDOT, and Illinois DOT. These DOTs have worked with local consulting companies and/or universities to identify opportunity zones and sites suitable for renewable energy and revenue generating projects on highway ROW, rest areas, and weigh stations. As with the wind turbines, sites were identified by overlaying ROW maps and GIS data layers with maps of potential renewable energy sources (i.e., solar, wind, geothermal, and biomass resource maps).

Carbon Sequestration

Carbon sequestration is the process of capturing and removing CO_2 and other forms of carbon from the atmosphere and then "storing" it in "reservoirs." A variety of techniques to sequester carbon exist, but the focus here is exclusively on vegetation management.

The U.S. has no formal carbon sequestration program besides the pilot programs and research studies conducted in New Mexico and Utah.

The Carbon Sequestration Pilot Program (CSPP), led by the FHWA's Office of Natural and Human Environment (ONHE) and the New Mexico Department of Transportation (NMDOT), reported that in addition to improved vegetation management, carbon sequestration allows for "(1) selling carbon credits on an appropriate



Source: FHWA (2010)

Figure VI.13: Carbon Sequestration

GHG market or registry for revenue, (2) using carbon credits to offset the DOT's emissions, or (3) using the credits toward meeting statewide objectives."

Biomass and Biofuel

The Utah DOT (UDOT) launched a research project in 2006 in conjunction with Utah State University (USU) to assess the feasibility of planting drought-tolerant crops such as canola, safflower, and dwarf sunflower along the ROW in a non-irrigated environment. The idea—as envisioned by the researchers—is to harvest enough seed to produce in-house biodiesel for the UDOT's fleet, including heavy diesel machineries and snow plows. As a result of the research, USU and UDOT could identify minimum requirements to initiate a biomass program.

Source: Volpe Center (2011)

Figure VI.14: Harvesting biomass on ROW

The North Caroline DOT (NCDOT) initiated in 2009 its biomass and biofuel project. Currently, the NCDOT's project is recognized as one of the largely successful biomass projects nationwide, mostly because of the state moist climate, fertile soil, and support from the state legislature. The project started with four 1-acre plots of canola or sunflower crops. These crops were selected by NCDOT, in conjunction with North Caroline State University, because their estimated greater potential of yield in ROW scenario. NCDOT has been working with seasonally rotated crops on the same plot, thereby being able to meet or exceed national standards for crop production. In 2010, NCDOT extracted 3,000 lb of canola seed, which yielded 100 gallons of virgin oil. The virgin oil produced 150 gallons of B100, which was cut with conventional diesel to generate approximately 600 gallons of B20. The NCDOT used the B20 to fuel its dump trucks, tractors, and other equipment.

Another pilot project is being conducted by Genera Energy LCC—a for-profit limited liability company wholly owned by the University of Tennessee Research Foundation—in partnership with Tennessee DOT. The objective of the pilot project is to verify if switchgrass—one of the primary feedstock used to produce cellulosic ethanol and native for all American states—planted along the highway ROW can yield reduced maintenance costs due to less mowing activities and erosion on the roadside, as well as generate revenue from biomass for biofuel production.

Wildlife Crossing

Wildlife overpasses are very common in Europe. North America, however, has only six examples of these structures, of which two are located in the Banff National Park in Alberta, Canada.

The Banff National Park and Trans-Canada Highway (in Alberta, Canada) have perhaps the "most recognizable wildlife crossings in the world" (Clevenger, 2006) with 22 underpasses and 2 overpasses.

The highway IH 75 (Florida) has 24 highway underpasses and 12 bridges that were modified for wildlife crossings along 40 miles. These crossing structures are "specifically designed to target and protect the endangered Florida panther" (Scott, 2007).

The Hoge Veluwe National Park in the Netherlands has three wildlife overpasses (called Ecoducts) across highway A50. It is estimated that in 1 year almost 5,000 deer and wild bears used at least one of the crossing structures.

Several DOTs and research centers have conducted studies regarding how to identify best location for wildlife crossing and design the structure effectively, including a Wildlife Decision Guide Framework.

Appendix VII: List of Stakeholders

Property Management

- Local government
  - Zoning/Planning department
  - Mayor/Council
- State government & Legislators
- Nearby landowners
- Nearby Businesses
- General public
- Potential buyers, developers, or investors
- Employees
- Transit agency
- Transportation Agencies (FHWA and AASHTO)
- Environmental Agencies
- General Land Office (GLO)

Property Management (Rest Area)

- Local government
  - Zoning/Planning department
  - Mayor/Council
- State government & Legislators
- Nearby landowners
- Nearby Businesses
- General public
- Potential Developers or Investors
- TXDOT Employees
- Transportation Agencies (FHWA and AASHTO)
- Utility providers
- Environmental Agencies
- Community Representatives
- General Land Office (GLO)

Airspace Leasing (Building)

- Local government
  - Zoning/Planning department
  - Mayor/Council
- Nearby landowners
- Nearby Businesses
- Nearby Residents
- General public
- Potential Developers
- TXDOT Employees
- Transit agency

- Utility providers
- Environmental Agencies
- Community Representatives
- Transportation Agencies (FHWA and AASHTO)

Airspace Leasing (Parking lot)

- Local government
    - Zoning/Planning department
    - Mayor/Council
    - Public Works/Transportation department
- Nearby landowners
- Nearby businesses
- Nearby Residents
- General public
- TXDOT Employees
- Police and fire Departments
- Transit agency
- Environmental Agencies
- Community Representatives
- Transportation Agencies (FHWA and AASHTO)
- Department of Public Safety

Airspace Leasing (Utilities)

- Local government
    - Zoning/Planning department
    - Mayor/Council
- Utility Providers
- Telecommunication Companies
- Tower Leasing Companies
- Oil & Gas Companies
- General Public
- FHWA
- Nearby Residents
- Nearby landowners
- TXDOT Employees
- Transit agency
- Federal Aviation Administration (FAA)
- Environmental Agencies
- Community Representatives
- State representatives for district
- Transportation Agencies (FHWA and AASHTO)

Advertising

- State government & Legislators
- Local Zoning/Planning department

- Advertising and Marketing Companies
- Nearby landowners
- Nearby Businesses
- Nearby Residents
- General public
- TXDOT Employees
- Transit agency
- Environmental Agencies
- Transportation Agencies (FHWA and AASHTO)

Solar Panel (ROW and Vacant Land)

- Local government
    - Public Works/City/Transportation department
    - Zoning/Planning department
    - Mayor/Council
- State government & Legislators
- Nearby landowners
- Community Representatives
- General public
- Developers or Investors
- TXDOT Employees
- Transit agency
- General Land Office (GLO)
- Utility Providers
- Department of Energy (DOE)
- Transportation Agencies (FHWA and AASHTO)
- Federal Aviation Administration (FAA)
- Environmental Agencies
- Solar Panel Vendors
- Telecommunication Companies
- Department of Defense (DOD)

Solar Panel (Building and Rest Area)

- Local government
    - Public Works/City/Transportation department
    - Zoning/Planning department
    - Mayor/Council
- State government & Legislators
- Nearby landowners
- Community Representatives
- General public
- Developers or Investors
- TXDOT Employees
- Transit agency
- General Land Office (GLO)
- Utility Providers

- Department of Energy (DOE)
- Transportation Agencies (FHWA and AASHTO)
- Federal Aviation Administration (FAA)
- Environmental Agencies
- Solar Panel Vendors
- Telecommunication Companies
- Department of Defense (DOD)

Wind Turbine (ROW and Vacant Land)

- Local government
    - Public Works/City/Transportation department
    - Zoning/Planning department
    - Mayor/Council
- State government & Legislators
- Nearby landowners
- Community Representatives
- General public
- Developers or Investors
- TXDOT Employees
- Transit agency
- General Land Office (GLO)
- Utility Providers
- Department of Energy (DOE)
- Transportation Agencies (FHWA and AASHTO)
- Federal Aviation Administration (FAA)
- Environmental Agencies
- Wind Turbine Vendors
- Telecommunication Companies
- Department of Defense (DOD)

Wind Turbine (Building and Rest Area)

- Local government
    - Public Works/City/Transportation department
    - Zoning/Planning department
    - Mayor/Council
- State government & Legislators
- Nearby landowners
- Community Representatives
- General public
- Developers or Investors
- TXDOT Employees
- Transit agency
- General Land Office (GLO)
- Utility Providers
- Department of Energy (DOE)
- Transportation Agencies (FHWA and AASHTO)

- Federal Aviation Administration (FAA)
- Environmental Agencies
- Wind Turbine Vendors
- Telecommunication Companies
- Department of Defense (DOD)

Geothermal Energy

- Local government
  - Public Works/City/DOT
  - Mayor/Council
  - Zoning/Planning department
- State government & Legislators
- Nearby landowners
- Community Representatives
- General public
- Developers or Investors
- TXDOT Employees
- Transit agency
- General Land Office (GLO)
- Utility providers
- Department of Energy (DOE)
- Transportation Agencies (FHWA and AASHTO)
- Federal Aviation Administration (FAA)
- Environmental Agencies
- Geothermal System Vendors
- Department of Defense (DOD)

Carbon Sequestration

- Local government
  - Public Works/City/DOT
  - Zoning/Planning department
- State government & Legislators
- Nearby landowners
- General public
- Developers or Investors
- TXDOT Employees
- General Land Office (GLO)
- Utility providers
- Department of Energy (DOE)
- Transportation Agencies (FHWA and AASHTO)
- Environmental Agencies
- Carbon Sequestration Experts
- Carbon Market Personnel

Biomass and Biofuel

- Local government
    - Public Works/City/DOT
    - Mayor/Council
    - Zoning/Planning department
- State government & Legislators
- Nearby landowners or Farmers
- Community Representatives
- General public
- Developers or Investors
- TXDOT Employees
- Utility providers
- Transit agency
- General Land Office (GLO)
- Department of Energy (DOE)
- Transportation Agencies (FHWA and AASHTO)
- Environmental Agencies
- Biofuel Suppliers (i.e., Gas Stations)
- Biofuel Companies (i.e., Biorefineries)

Wildlife Crossing

- Local government
    - Public Works/City/DOT
    - Mayor/Council
    - Zoning/Planning department
- State government & Legislators
- Nearby landowners
- Community Representatives
- General public
- Developers or Investors
- TXDOT Employees
- Transit agency
- General Land Office (GLO)
- Insurance Companies
- Transportation Agencies (FHWA and AASHTO)
- Environmental Agencies
- Department of Defense (DOD)

Appendix VIII: Workshops

During the final stages of the project the researchers conducted a series of facilitated workshops to gather feedback and finalize the VEA. Input that was obtained from TxDOT's Dallas, El Paso, Houston, Paris, Tyler and Yoakum Districts on the information collected and the VEA framework developed by the research team.

Workshop attendees asked a series of questions of the research team. While these were not all necessarily germane to the issue of value extraction the team reviewed these issues and at the final project meeting provided responses to the questions.

Question 1: Apparently, farmers can complete a TxDOT maintenance form to obtain permission to harvest grass on TxDOT's ROW? TxDOT calls it an agricultural lease? Can you find out whether TxDOT charges a fee to these farmers? What is the process? Someone mentioned that permission is needed from every landowner adjacent to TxDOT's ROW.

Texas TC Chapter 202 – control of transportation assets – sets out the rules for agreement to use or cultivate right of way, as well as mowing baling, shredding and hoeing.

Section 202.059 allows a DE, at the request of a person (but they are not required to) permit a person to mow, bail, shred or hoe material on ROW. If this person is not the owner of the property adjacent to the right of way, the DE must provide the owner of the property adjacent to the right of way the option to do this, before they can grant permission to the other person (202.059 (b)). Section 202.059 (c)) ***forbids the person who is doing this activity from receiving compensation for the activity***, but they are allowed to use or dispose of the hay or other material produced. There is no mention anywhere in the code authorizing TxDOT to charge a fee for this activity.

In order to charge a fee TC will have to be amended, and then the agency would have to create regulations to implement this.

Question 2: In the Yoakum District, the sponsoring of the cleaning/ maintenance of the picnic areas was seen as another potential VEA. Apparently, it costs the Districts some money to maintain these areas. Can you see if any legislation has been proposed to allow companies to sponsor the "maintenance and cleaning of these sites"?

TAC Title 43 Transportation Chapter 12 public participation in landscaping and litter removal is the only area of code where there is a specific program in place for public engagement/sponsorship. This lays out the rules for Adopt a Highway, the Landscape Costs Sharing Program, Adopt a Freeway Program, Landscape Partnership program, Adopt a Highway for Landscaping Program and a couple of other programs for airports. The purpose and scope in Rule 12.1 finds that *"…to increase public awareness of the maintenance needs of the state highway and airport systems, improve the aesthetics of state highways and airports, and* *maximize the use of taxpayer revenue, it is the policy of the Texas Transportation Commission to encourage public participation in the maintenance, landscaping, and beautification of the state highway and airport systems through the creation of programs whereby local governments and private entities may adopt sections of the state highway system or airports for litter pickup, routine maintenance, landscaping, and beautification."*

This section could be used to create an 'Adopt a Picnic Area Program' or 'Adopt a Rest Area Program' by the department, given the parameters of the purpose and scope.

TxDOT's Maintenance Operations Manual (2010) notes that there are forty picnic areas considered to be historically significant and eligible for listing in the national register. TxDOT made a commitment in 1994 to the Texas Historical Commission to retain as many historic picnic areas as possible.

TC, Chapter 202. Section 202.051 (1) defines a highway asset, and Section 202.051 (2) defines *rest areas* as area of public land designated by the department as a rest area, comfort station, picnic area, or roadside park. TC Section 202.055 allows the department to lease a rest area to someone engaging in sales, *services*, or *other commercial activities* that 'serve the needs of the travelling public.' Presumably keeping these areas maintained and clean would serve the needs of the travelling public. Section 202.055 (b) requires the department to ensure that the area is maintained in a proper manner and any damages are repaired.

The department can also lease a highway asset under TC Section 202.052 – if it determines it will not be needed for a highway purpose. The department cannot charge less than fair market value that is payable in case, ***services***, tangible or intangible property or combination thereof (202.052 (c)). The department can also authorize *exceptions to the charg*es under 202.052 (d) (2) if this is for a social, environmental or economic mitigation purpose. Possibly services could cover the sponsorship component for cleaning/maintaining the area. If the agency chose not to charge they could utilize the exception clause to make this a no-cost lease from the department.

TAC Title 43 Transportation, Subchapter L on leasing of highway assets sets out the rules for this activity (§21.600). Under §21.602 the commission can authorize such a lease if the asset won't be needed for highway purposes, will be consistent with safety, maintenance, operation and beautification of the highway system, will be ***economically beneficial*** to the department. The lease cannot exceed 2 years.

<u>Federal Rules</u>

U.S. Code has no sections in it at Title 23 Highways regarding leasing maintenance/sponsorship of sites. Title 23: Highways Code of Federal Regulations sets out the regulations for the federally aided segments of the highway system including interstates.

Within Title 23 at Part 752 landscape and Roadside Development Section 752.5 Safety Rest Areas sets out the regulations for these areas. States are to provide these facilities reasonably necessary for the comfort, convenience, relaxation and information needs of the motorist. No charge can be made to the public for goods and services except for telephone and items from vending machines. There is nothing in the rules about leasing/sponsoring out the maintenance/upkeep of these areas.

Within Title 23 Part 710 Right of Way and Real Estate – the regulations at Section 710.401 and 701.403 govern real property management. Under 710.401 the state DOTs are given responsibility for control and use of property where federal funds participated. For any change in access control or other use along the interstate the DOT must apply to the FHWA for such a change. The DOT is required to stipulate in its ROW operations manual, procedures for rental, leasing, maintenance, and disposal of property.

There is nothing in the rules about leasing/sponsoring out the maintenance/upkeep of rest areas.

Question 3: Whole issue with driveway permits – Many respondents wanted to know why TxDOT cannot charge for driveway permits? Can you look into this and maybe see how much our neighboring DOTs are charging for installing driveway permits?

State Review on Drive Permit Charges

The research team initially reviewed the states surrounding Texas: New Mexico (NM), Oklahoma (OK), Louisiana (LA), and Arkansas (AK). Nothing could be found in in NM Code on access management specifically for driveways, and there was nothing that could be found on the NM DOT website. Similarly, there was nothing that was found in OK code or their DOT's website.

In Louisiana the Revised Statutes at – RS 48:301 and 302 and 48:344 had some information. . Louisiana Administrative Code title 70 Transportation Part I, Chapter 15 laid out the access connection permits stipulations. There is no cost for permit (Louisiana DOT – Access Connections Policy to accompany LAC Title 70 Part 1 Chapter 15- updated Nov. 2011 (accessed from http://www.dotd.la.gov/highways/maintenance/maintmgt/home.aspx).

The research team then reviewed some other comparable states to Texas. In North Carolina the cost for constructing/maintaining a drive way access connection is born by property owner and permit applicant. North Carolina's DOT does not charge for the driveway permit. (Policy on Street and Driveway Access to North Carolina Highways, July 2003). In Wisconsin there is no charge for a permit.

Colorado there is no charge for permit itself – but they can charge an hourly/daily fee for closure of any lanes necessary to construct the private access. Each issuing authority can set this fee. (State of Colorado State highway Access Code Vol. 2 Code of Colorado Regulations 601-1, March 2002).

New York charges for the permit based on type of operation – this ranges from $15 to $2000 for the application for non-utility work. It is known as the PERM 33 08/01 (accessed from https://www.dot.ny.gov/divisions/operating/oom/transportation-systems/traffic-operations-section/highway-permits and www.dot.ny.gov/divisons/operating/oom/transportation-systems/repository/perm33.pdf)

Washington DOT – application for access connection requires a fee – determined by permit category type (Washington Administrative Code 468-51 and Revised Code of Washington Chapter 47.50 and RCW Chapter 47.32). The Applicant will also pay any additional amounts billed, in the reimbursement of actual costs to the department (accessed from http://www.wsdot.wa.gov/Northwest/DevelopmentServices/AccessServices.htm).

The permit costs for Washington are:
Cat I – $50–500
Cat II – $1000–1500
CAT III – $2500–4000
Temporary $100
(accessed from www.wsdot.wa.gov/NR/rdonlyres/0782B339-B92A-4A6B-9D865178EB36/0/DOTform224694EFEditable4.pdf).

Florida charges for the permit based on a vehicle trips per day method. The Florida State Highway System Connection Permits information can be found at http://www.dot.state.fl.us/onestoppermitting/ and also https://www.flrules.org/gateway/ChapterHome.asp?Chapter=14-96).

Section 14-96.004 Connection Categories and Fees.
All connections, public or private, shall be determined by the Department to be in one of the following categories:

(1) Standard Connection Categories. The following table summarizes the standard connection categories and application fees:

Description	Projected Average Application Vehicle Trips Per Day of Site	Fee
Category A	Uses to 20 VTPD	$50
Category B	Uses with 21 - 600 VTPD	$250
Category C	Uses with 601 - 1,200 VTPD	$1,000
Category D	Uses with 1,201 - 4,000 VTPD	$2,000
Category E	Category E – Uses with 4,001 - 10,000 VTPD	$3,000
Category F	Uses with 10,001 - 30,000	$4,000
Category G	Uses with 30,001 + VTPD	$5,000

(2) Special Connection Categories.

(a) "Temporary Connection Category" provides a temporary, time limited connection to the State Highway System for a specific property, use, and estimated traffic volume. Such uses may include forest land clearing and temporary agricultural or construction uses. This category may not be used for permanent construction at a site where it is reasonably expected that the use is the ultimate use of the property. Further, a temporary connection permit does not bind the Department in any way to the future issuance of a permanent connection permit at the temporary connection location. The permittee shall remove, at the permittee's own cost, the temporary connection at the end of the permit period or shall apply for an extension or a new permit. The fee for this category is $250 for a six month period. The period will be extended for increments of six months upon written request, payment of a new fee, and a showing of good cause, such as weather delays, natural disasters, governmental entity coordination delays, or other technical problems not within the control of the applicant. However, in no event shall the period extend beyond 24 consecutive months. The Department reserves the right to remove any temporary connection upon expiration of the permit.

(b) A "Government Entity Category" provides for a connection or connection modification for any new or substantially improved public road or connection to a governmental facility. The fee will be waived if the applicant is a governmental entity.

(c) "Safety Upgrade Category" shall not be used for connections involving significant change. These applications shall be initiated by the applicant and will not require a fee.

(3) Phased Developments. New phases of an existing development requiring a new permit will have their fee based on the development in the individual phase.

(4) Fee Payment Type. Full payment of fees shall be made by cashier's check, certified check, personal or business check, cash, or money order, and shall be made payable to the State of Florida Department of Transportation at the time of application. Checks drawn on governmental entity accounts will be accepted by the Department. The use of pre-paid accounts are also allowed in accordance with the Department's pre-paid account practices. If at any time during the application process a check for the fee is returned for insufficient funds, the applicant will be notified that the application is not complete and no further processing will occur until a cashier's check, certified check, personal or business check, cash, or money order is presented. The application fee is non-refundable, as required by Section 335.183, F.S.
Specific Authority 334.044(2), 335.182(2), 335.183, 335.184 FS. Law Implemented 334.044(14), 335.18-.187 FS. History–New 4-18-90, Amended 7-16-95, 1-23-03, 1-25-04, 3-19-06.

Question 4 :Mailboxes - The other issue is the installation of the mailboxes? Apparently, TxDOT is also responsible for the latter, but does not charge anything.

Again the research team reviewed surrounding states and then looked at some other comparator states. There were very few states that charged for mailbox installation.

In Louisiana the applicant requests permission and authority to install a mailbox – no mention anywhere of costs. Louisiana Administrative Code Title 70 Transportation at Part II Utilities is the only specific area in the regulations where mailboxes are mentioned in Section 572 - miscellaneous.

The Alaska DOT will replace mailboxes when new road construction takes place. In all other situations property owners are responsible for installing and maintaining mailboxes (see http://www.dot.state.ak.us/stwddes/dcstraffic/mailbox/index.shtml).

Virginia also was found to not have any specific formal permitting system for placing mailboxes on right of way (Virginia – DOT Chapter 150 Land Use Permit Manual). 24 Virginia Administrative Code (VAC) 30-150-20 sets out the general rules and regulations of the Commonwealth Transportation Board. Within 24 VAC 30-15-20 K. Mail boxes and newspaper boxes may be placed on the right of way of any system of state highways without a permit, but shall be so placed as not to, in the opinion of the commissioner, interfere with the safety, maintenance and use of the highway. Such opinion is to be found in the department's Land Use Permit Manual. Under 24VAC30-150-1910. Mailboxes; newspaper boxes no formal permits are required for the placing of mailboxes or newspaper boxes on the right of way (Statutory Authority: §33.1-12 of the Code of Virginia - derived from VR385-01-16 §5.110; eff. November 15, 1983.).

24VAC30-150-1920. Mailboxes notes that Guidelines for the placing of mailboxes are outlined in Section 3.241 of the Maintenance Division Policy Manual (see www.virginiadot.org/business/). Statutory Authority is found in §33.1-12 of the Code of Virginia. Derived from VR385-01-16 §5.111; eff. November 15, 1983.

Appendix IX: “Potential Value Extraction from TxDOT’s Right-of-Way and Other Property Assets”

Potential Value Extraction from TxDOT's Right-of-Way and Other Property Assets

Austin, Texas

February 21, 2012

Research Tasks

- Task 1: Review Previous Reports and Documented Research
- Task 2: Assess Legal Issues/Concerns
- Task 3: Identify Best Practice Value Extraction Applications
- Task 4: Develop Stakeholder Analysis Framework
- Task 5: Conduct Public Outreach and Finalize Value Extraction Application Methodological Framework
- Task 6: Document Research

Research Tasks

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Task 5 – District Outreach

Task 5 - Objectives

"… to (a) implement the stakeholder analysis framework by facilitating four to six stakeholder outreach efforts in different geographic/spatial (e.g., urban, rural, semi-urban) contexts to review the "Best Practice" case study value extraction applications, potential benefits, risks, and opportunities and (b) to use the feedback received to finalize the Value Extraction Application methodological framework."

District Outreach

- Houston
- Dallas
- El Paso
- Yoakum
- Tyler
- Paris
- Pharr

District Outreach

District	Number of Participants
Houston	6
Dallas	6
El Paso	6
Yoakum	2
Tyler	11
Paris	5

District Outreach

- Research objective and tasks
- Reviewed identified VEAs
  - 11 potential VEAs
  - Summarized important findings
- Reviewed VEA framework developed
- Reviewed stakeholder outreach guidance
- Concluding remarks
- Invited District staff input

Houston

- Property management is and should be done at the District level
- Barter transactions – DOT staff often feel unsure about developer intentions
- Very interested in Adopt-a-Watt program
- Problem with pelicans – no wildlife crossings for birds

Paris

- Surplus numerous properties
- Closed picnic areas
- Rest area privatization regarded a good idea
  - Oklahoma example
- ROW leasing utilities
  - Very strong utility lobby
- Biomass (e.g., hay production) regarded good idea
  - Save agency mowing cost

Tyler

- Rest areas
  - Chamber were charging for wedding events
  - Resulted in issues with cleaning site
- Air space leasing – utilities
  - Concern about access to ROW by private entity
  - Bidding process – how much revenue?
- Parking lot
  - Access to TxDOT's infrastructure

Tyler

- ROW for agriculture/biomass production
  - Already implemented in coastal areas (hay)
  - Require permission from adjacent property owners – TxDOT recommend change in permitting process
  - Potential to reduce mowing costs
  - Require longer term leasing agreement (farm and bale grass)
- Rather allow TxDOT to charge for driveway permits and mailbox installations

El Paso

- Wind turbine
  – Wind speed at 100 mph blew off rotor and blades
  – Reliability issues
- Solar panels good idea for El Paso
  – Office facilities rather than ROW
- Barter transactions have been implemented
- Airspace leasing – buildings
  – Casino over highway

El Paso

- Parking arrangements under highways
  - Prevent hazmat trucks from parking
- Charging for utilities in ROW, driveway permits, and mail boxes

Dallas

- Number of property barter transactions in Dallas
- Blue Signs (TOD)
  - Total $ generated by TxDOT
- TxDOT does not retain mineral rights on property
  - Value of oil and gas extracted from under ROW

Dallas

- Dallas explored all VEAs
  - Only limitation is legal requirements
- Property management
  - No incentive to surplus property, because revenue goes to GLO
- Advertising and rest areas
  - Financially most lucrative VEAs for Dallas

Yoakum

- TOD/ Blue signs
  - Potential source of revenue
- Agriculture/Biomass production
  - Switchgrass – a big NO
- Picnic areas
  - Cost associated with maintenance and cleaning
  - Sponsorship an alternative to closing

Mowing, baling, shredding hoeing

- Transportation Code (TC) §202.059 allows this activity
  - DE can permit
- Anyone can make this request
  - If not owner of adjacent property, DE must provide owner of this property option do undertake this.
- TC forbids person doing the activity from receiving compensation
  - They can use or dispose of hay/other material produced
  - No authorization in code for TxDOT to charge a fee for this activity

Cleaning/Maintenance of Picnic areas

- United States Code
  - No language in code regarding rest area sponsorship
- Code of Federal Regulations
  - No language regarding rest area sponsorship for cleaning/maintenance.
  - States given latitude to set own rules/regs for these areas

Cleaning/Maintenance of Picnic areas

- Texas Administrative Code (TAC) Title 43 Transportation Chapter 12 Public Participation
  - Allows public participation in landscaping and litter removal
    - Adopt a freeway and other such programs created under this rule
    - Theoretically could create an adopt a picnic area program
    - Maintenance manual – 40 picnic areas considered historic - TxDOT made commitment in 1994 to Texas Historical Commission to retain as many as possible
      - Theoretically setting up such a program could assist it to continue attain this commitment

Cleaning/Maintenance of Picnic Areas

- TC 202.051 – definitions of highway asset
  - Rest area is defined here
- TC 202.055 allows department to lease a rest area to someone engaged in sales, services, or other commercial activities that serve needs of travelling public
  - Maintenance/cleaning could fall within the services section, and would serve needs of travelling public
- Lease must be at fair market value
  - There is an exception clause to charges if for social/environmental/mitigation purpose 202.052 (d)(2)

Driveway Permit Charges

- New Mexico – nothing in their code
  - NMDOT Website couldn’t find anything either
- Oklahoma – nothing on website
- Louisiana – no cost for permit
- North Carolina – no cost for permit
- Colorado – no cost for permit, but they are allowed by regulations to charge hourly/daily fee for closure of any lanes necessary to construct the private access

Driveway Permit Charges

- New York – charges for permit based on type of operation this ranges from $15 to $2000 for the application of non utility work – called a PERM 33.
- Washington application for access connection permit requires a fee that is determined by a set of categories
  - CAT I $50-500
  - CAT II $1000-1500
  - CAT III $2500-4000
  - Temporary Driveway $100

Driveway Permit Charges

- Florida charges a connection application fee based on a series of categories- that is based on average vehicle trips per day of site
  - CAT A – 20 VTPD $50
  - CAT B – 21-600 VTPD $250
  - CAT C – 601-1,200 VTPD $1,000
  - CAT D – 1201-4,000 VTPD $2,000
  - CAT E – 4,001-10,000 VTPD $3,000
  - CAT F– 10,001-30,000 VTPD $4,000
  - CAT G – Uses 30,001 + VTPD $5,000

Mailboxes

- Louisiana – applicant requests permission – no mention anywhere of who bears costs
  - Louisiana Administrative Code Title 70 Transportation at Utilities under miscellaneous, is the only specific area in the regulations I could find any mention of mailboxes.
    - No mention of cost
- Alaska- DOT will replace mailboxes when new road construction takes place.
  - In all other situations property owner are responsible for installing and maintaining to state standards
- Virginia – mailboxes may be placed on ROW without a permit, but not so to interfere with safety, maintenance and use
  - No mention in Code of Virginia about costs

Concluding Remarks

- District staff interested in information collected
- Not all districts interested in using VEA framework to pursue VEA implementation
- Some suggested charging for driveway permits and mailboxes
- Rest are privatization and advertising supported
- ROW "farming" to reduce mowing cost

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References

General

I. 2030 Committee, “Texas Transportation Needs Report,” (February, 2009)

II. ASSHTO, “Revenue Sources to Fund Transportation Needs,” (September, 2007)

III. Clemen, Robert T. and Reilly, Terence. “Making Hard Decisions with DecisionTools,” published by Duxbury (2001).

IV. Persad, Khali R., “TxDOT Revenue and Expenditure Trends,” (April, 2009)

V. U.S. FHWA - John A. Volpe National Transportation Systems Center (Volpe Center). “Alternative Uses of Highway Right-of-Way: Accommodating Renewable Energy Technologies and Alternative Fuel Facilities,” DRAFT (June, 2011)

Property Management

I. Caltrans, Property Management, available at http://www.dot.ca.gov/doingbusiness.htm (October, 2010)

II. Iowa DOT, Property Management, available at http://www.iowadot.gov/propmanage/propmanage_brochure.html (May, 2011)

III. Susan Combs Texas Controller of Public Accounts and TxDOT; “A review of the Texas Department of Transportation: Paving the Way” (2001) available on http://window.state.tx.us/txdot (chapter 6).

Rest Areas

I. AASHTO Journal, “Georgia DOT Solicits Ads To Pay Maintenance Costs” (April, 16th of 2010).

II. Department of Civil and Environmental Engineering, The University of Maine, Report No. NETCR 38 “Quantifying Roadside Rest Area Usage,” Maine, (November, 2002).

III. Euritt, M. A.; Harrison, Robert; Grant, Susa; “Feasibility of Safety Rest Area Commercialization in Texas,” Center of Transportation Research (1992)

IV. Federal Highway Administration (FHWA); “Feasibility of Financing Public Information in Rest Area Interactive Kiosks through Private Advertising” (1996).

V. Kalla, Hari; “Interstate Oasis Program” presented at Talking Freight Seminar (2006).

VI. NCSDR/NHTSA; “Drowsy Driving and Automobile Crashes,” available at http://www.nhtsa.gov/people/injury/drowsy_driving1/drowsy.html (2010)

VII. SFR Consulting Group, INC “Analysis of Vehicle Crashes Related to Safety Rest Area Spacing,” Report prepared for Minnesota Department of Transportation, (July, 2007).

VIII. Stateline.org, “As some states close highway rest stops, others see roadside revenue” (July, 28th of 2010).

IX. Wikipedia, “Illinois Tollway oasis,” available at http://en.wikipedia.org/wiki/Illinois_Tollway_oasis (September, 2010)

Airspace Leasing for Buildings

I. Broils-Cox, Robin; “Air Space Security” presented for FHWA Office of Real Estate Services (2008)

II. Iacono, Michael; Levinson, David; Zhao, Zhirong (Jerry); and Lari, Adeel; "Value Capture for Transportation Finance: Report to Minnesota Legislature" (June 2009)
III. Savvides, Andreas L., "Bridging the Urban Arterial – The Premium for Reconnecting the Urban Fabric, Boston Architectural Center, and FHWA (2005).
IV. Texas Transportation Institute (TTI), Report No. FHWA/TX-93/1329-1F "Leasing of TxDOT's Right-Of-Way," (September, 1993).
V. U.S. Department of Transportation, Federal Highway Administration, available at www.fhwa.dot.gov (September, 2010)
VI. U.S. Department of Transportation, Federal Highway Administration, "Airspace Guidelines to 23 CFR 710.405 – 710.407" (2010)
VII. Wikipedia, "Air Rights," available at http://en.wikipedia.org/wiki/Air_rights (April, 2011)
VIII. Wikipedia, "Illinois Tollway oasis," available at http://en.wikipedia.org/wiki/Illinois_Tollway_oasis (April, 2011)

Airspace Leasing for Parking Lot

I. Box, Paul C.; "Curb-Parking Problems: Overview" (2004)
II. Broils-Cox, Robin; "Air Space Security" presented for FHWA Office of Real Estate Services (2008)
III. California Department of Transportation (Caltrans), "Airspace Alchemy: Turning Unused Space into Revenue!" (2009)

Airspace Leasing for Utilities and Telecommunication

I. AASTHO – Funding & Financing, "Shared Resources," available at http://www.transportation-finance.org/funding_financing/funding/other_funding_sources/shared_resources.aspx (January, 2011)
II. Florida ITS, "Lodestar Communications," available at http://www.floridaits.com/newsletters/its_nwltr_3/lodestar.htm (July, 2001)
III. The Central Federal Lands Highway Division (CFLHD), available at http://www.cflhd.gov/ (January, 2011)
IV. U.S. Department of Transportation, "Shared Resources: Sharing Right-of-Way for Telecommunications – Final Report" (April, 1996)
V. U.S. Department of Transportation, Federal Highway Administration, and Public Roads: "Wireless Communication: A Modern Necessity," Vol 63, No5 (2000)
VI. U.S. Department of Transportation, Federal Highway Administration: "Guidance on Utilization of Highway Right-of-Way," available at www.fhwa.dot.gov/realstate/guidutil_a.htm (January, 2011)
VII. U.S. Department of Transportation, Federal Highway Administration, "Airspace Guidelines to 23 CFR 710.405 – 710.407" (2010)

Advertising

I. AARoads Interstate Guide, "Interstate 294 Illinois," available at http://www.interstate-guide.com/i-294_il.html (October, 2010)
II. AARoads Interstate Guide, "Interstate 878 New York," available at

http://www.interstate-guide.com/i-878_ny.html (October, 2010)

III. AASHTO – Funding and Financing, “Advertising,” available at http://www.transportation-finance.org/funding_financing/funding/other_funding_sources/advertising.aspx (January, 2011)

IV. AASHTO – Funding and Financing, “Naming Rights,” available at http://www.transportation-finance.org/funding_financing/funding/other_funding_sources/naming_rights.aspx (January, 2011)

V. AASHTO Journal, “Florida DOT Raises Prices for Businesses to Advertise” (2010)

VI. AAW, “National Adopt-a-Watt Program,” available at http://adopt-a-watt.com/ (May, 2011)

VII. Adopt-A-Highway Program, available at www.adoptahighway.com (January, 2011)

VIII. Chabot, Hillary at Boston Herald; “’EZ’go:Pike to lose $500G” published online on December 5th, 2010, available at http://www.bostonherald.com/news/politics/ (December, 2010)

IX. LoneStar Logo & Signs, available at http://www.lone-starlogos.com/ (January, 2011)

X. Oregon Travel Information Council (OTIC), “Rest Area Advertising Opportunities,” available at www.oregontic.com (October, 2010)

XI. Storeyco, “Washington Rest Area Brochure Program,” available at http://www.storeyco.com/m-images/RA-BrochDistribution.pdf (October, 2010)

XII. TexTrek, “Your Online Texas Tour Guide,” available at http://www.textreks.com/ (October, 2010)

XIII. The Council of State Governments (CSG), “New Transportation Revenue Streams or Distracting Safety Hazards?” (2010).

Solar Panel

I. Borenstein, Severin, “The Market Value and Cost of Solar Photovoltaic Electricity Production” (2008)

II. Chapa, Jorge; “Could Solar Highways Power our Cities?,” available at http://inhabitat.com/could-solar-freeways-power-our-cities/ (August, 30th 2008)
Database of State Incentives for Renewable & Efficiency (DSIRE), available at http://www.dsireusa.org/incentives/incentive.cfm (October, 2010)

III. Garfield Clean Energy, available at http://www.garfieldcleanenergy.org/ (2010)

IV. Green Solar and Wind Power; “Residential Solar Panel,” available at http://www.solar-green-wind.com/archives/tag/residential-solar-panel-roof (May, 2010)

V. National Renewable Energy Laboratory (NREL), “ Solar Maps,” available at http://www.nrel.gov/gis/solar.html (October, 2010)

VI. Oregon Department of Transportation, “Innovative Partnerships Programs – The ODOT Solar Highway” (2010).

VII. Oregon Department of Transportation, “The Oregon Solar Highway” presented at APWA Fall Conference by Allison Hamilton (2009).

VIII. PVResources, “Photovoltaic economics” (2010), available at http://www.pvresources.com/en/economics.php (October, 2010)

IX. PV-tech.org, “German highway solar PV using Evergreen Solar panels nears completion” (Feb, 2009).

X. SolarBuzz, "Economic Payback of Solar Energy System" (2010), available at http://www.solarbuzz.com/Consumer/PayBack.htm (October, 2010)

XI. SolarBuzz, "Photovoltaic Industry Statistics: Costs," available at http://www.solarbuzz.com/StatsCosts.htm (October, 2010)

XII. State Energy Conservation Office (SECO), "Photovoltaics: Solar Electricity," available at http://www.seco.cpa.state.tx.us/re_solar_pv.htm (October, 2010)

XIII. State Energy Conservation Office (SECO), "Texas Solar Energy" , available at http://www.seco.cpa.state.tx.us/re_solar.htm (October, 2010)

XIV. State Energy Conservation Office (SECO), "Texas Tax Code Incentives for Renewable Energy," available at http://www.seco.cpa.state.tx.us/re_incentives-taxcode-statutes.htm

XV. State Energy Conservation Office (SECO); "Texas Renewable Energy Resource Assessment" – Chapters 1 and 3 (2008).

XVI. State Energy Conservation Office (SECO); "Texas Renewable Portfolio Standard" (October, 2010)

XVII. U.S. FHWA - John A. Volpe National Transportation Systems Center (Volpe Center). "Alternative Uses of Highway Right-of-Way: Accommodating Renewable Energy Technologies and Alternative Fuel Facilities," DRAFT (June, 2011)

XVIII. Wiser, Ryan; Barbose, Galen; and Peterman, Carla; "Tracking the Sun – The Installed Cost of Photovoltaics in the U.S. from 1998-2007," Lawrence Berkeley National Laboratory (2009).

Wind Turbine

I. Abuelsamid, Sam; "Highway Wind Turbines to Capture Energy from Passing Vehicles," available at http://www.green.autoblog.com/2007/05/01/highway-wind-turbines-to-capture-energy-from-passing-vehicles/ (May, 1st 2007)

II. BBC News; "Wind Turbines on City Tower Block," available at http://news.bbc.co.uk/2/hi/uk_news/england/manchester/4648371.stm (July, 4th 2005)

III. Cavanaugh, Rebecca; "The New Jersey Barrier: Mark Oberholzer explores the urban highway's potential for wind power.," available at http://www.metropolismag.com/story/20070110/the-new-i-jersey-barrier (January, 10th 2007)

IV. Chapman, Patrick and Wiczkowski, Piotr; "Wind-Powered Electrical System – Highway Rest Areas, Weigh Stations, and Team Section Buildings" – University of Illinois at Urbana Champaign (2009).

V. Dreamstime; "Wind turbine generators by a highway," available at http://www.dreamstime.com/royalty-free-stock-photography-wind-turbine-generators-by-a-highway-image12457867 (2011)

VI. Hemphill, Stephanie; "Some energy-intensive industries taking steps to go green," available at http://minnesota.publicradio.org/display/web/2009/12/09/business-greenhouse-emissions/ (December, 10th 2009)

VII. Hoffman, Doug L.; "Wind Power: Green and Deadly," available at http://www.theresilientearth.com/?q=content/wind-power-green-and-deadly (March, 5th 2010).

VIII. Homepower Magazine, "Wind Electricity Basics," available at http://homepower.com/basics/wind (October, 2010)

IX. KMBC.com (Kansas City), "Wind Turbine Along I-435 Generates Stares" (2009)

X. NY-Attraction;"Really Big Windmills in Holland," available at http://ny-attractions.com/img/5e/5eb/Really_big_windmills_in_Holland_aka_wind_turbines_in_the_Nederlands.jpg (2011)
XI. OC Safety News; "OSHA to Focus on Wind Energy Safety Next Year," available at http://ocsafetynews.com/2011/06/06/osha-to-focus-on-wind-energy-safety-next-year/ (June, 6th 2011)
XII. Piepkorn, Mark; "Big Wind Turbines Failures," available at http://www.buildinggreen.com/live/index.cfm/2008/10/29/Big-Wind-Turbine-Failures (October, 29th 2008)
XIII. Proctor, Cathy; "Wind turbines sought along I-70 stretch" published online at Denver Business Journal (2010)
XIV. Shoemaker, Jace; "Massachusetts Turnpike's Rest Area is Getting Greener" published at EnergyBoom.com on January 15th, 2010.
XV. State Energy Conservation Office (SECO); "Texas Renewable Energy Resource Assessment" – Chapters 4 (2008).
XVI. Tillinghast, Eleanor; "Wind turbines don't make good neighbors – Some problems of Wind Power in the Berkshires" (2004), available at http://www.greenberkshires.org/wind_power_postings/wind_turbines.html
XVII. U.S. Department of Energy (DOE), "Small Wind Electric System: A U.S. consumer's Guide" (March, 2005)
XVIII. U.S. FHWA - John A. Volpe National Transportation Systems Center (Volpe Center). "Alternative Uses of Highway Right-of-Way: Accommodating Renewable Energy Technologies and Alternative Fuel Facilities," DRAFT (June, 2011)
XIX. Voelcker, John; "Could Passing Cars Power Wind-Turbine Highway Lights?," available at http://www.greencarreports.com/news/1042537_could-passing-cars-power-wind-turbine-highway-lights (February, 12th 2010)
XX. WindEnergy7; "Rooftop Wind Generator Kit, Hybrid Wind/Solar," available at http://windenergy7.com/turbines/tag/wind-generator/ (October, 8th 2008)

Special Road

I. Innowattech Energy Harvesting Systems, available at http://www.innowattech.co.il/ (November, 2010)
II. Piezoelectric Generator, available at http://renewableenergyresource.net/renewable-energy-sources/piezoelectric-generator (November, 2010)
III. Solar Roadways, available at http://solarroadways.com/vision.shtml
IV. The Green Optimistic, "Israel Highway Equipped with Pilot Piezoelectric Generator System" (2009)

Geothermal Energy

I. ESM Energy Systems & Materials; "Geothermal Energy Solution," available at http://www.esm-corporation.com/services/geothermal-energy-solution/ (2010) http://serc.carleton.edu/research_education/yellowstone/geothermal.html (2010)
II. Kirk, Karin; "Should geothermal energy resource around Yellowstone Part be Developed?" – Montana State University, available at

III. Lxrichter, "Idaho sees a run on geothermal leases on state land" published on ThinkGeoenergy.com (2010)
IV. Lxrichter; "Geothermal could be significant source of power in Idaho," available at http://thinkgeoenergy.com/archives/8161 (July, 24th 2011)
V. Planet Earth and Humanity Blog, available at http://planetearthandhumanity.blogspot.com/2011/07/future-of-geothermal-energy.html (December, 2010)
VI. State Energy Conservation Office (SECO), "Texas Geothermal Energy," available at http://www.seco.cpa.state.tx.us/re_geothermal.htm
VII. State Energy Conservation Office (SECO); "Texas Renewable Energy Resource Assessment" – Chapters 7 (2008).
VIII. U.S. FHWA - John A. Volpe National Transportation Systems Center (Volpe Center). "Alternative Uses of Highway Right-of-Way: Accommodating Renewable Energy Technologies and Alternative Fuel Facilities," DRAFT (June, 2011)
IX. Wendell A., Duffield, and John H. Sass; "Geothermal Energy – Clean Power From the Earth's Heat" (2003)

Carbon Sequestration and Biomass & Biofuel

I. Burke, Jennifer; "Genera Energy Partners with TDOT to Plant Swicthgrass along Interstates – Renewable Energy Crops Could Reduce Maintenance Costs" (2010)
II. Energy Insight; "Biofuels from Switchgrass: Greener Energy Pastures," available at http://www.energyinsights.net/cgi-script/csArticles/articles/000029/002996.htm (April, 11th 2007)
III. Gehlhar, Mark; Winston, Ashley; and Somwaru, Agapi ; "Effects of Increased Biofuels on the U.S. Economy in 2022" (2010).
IV. Genera Energy, "Genera Energy Partners with TDOT to plant Switchgrass along Interstates," available at http://www.generaenergy.net
V. Hanks, Dallas; "Freeways to Fuel" (2009) http://www.fhwa.dot.gov/hep/climate/carbon_sequestration/index.htm
VI. Marin, Lucian E.;"Corn Walking," available at http://allyreeves.wordpress.com/2008/03/ (March, 008)
VII. Minnesota Department of Transportation – New Release, "Planting crops on road right of way is illegal and can create safety problem" (April, 26th of 2006).
VIII. ScienceDaily; "Biofuel: Major Net Energy Gain From Switchgrass-Based Ethanol," available at http://www.sciencedaily.com/releases/2008/01/080109110629.htm (January, 9th 2008)
IX. State Energy Conservation Office (SECO); "Texas Renewable Energy Resource Assessment" – Chapters 5 (2008).
X. U.S. Department of Transportation Federal Highway Administration (FHWA) and John A. Volpe National Transportation Systems Center (Volpe Center), "Carbon Sequestration Pilot Program: Implementation and Next Steps – Progress Report," February 2009
XI. U.S. Department of Transportation Federal Highway Administration (FHWA), "Carbon Sequestration Pilot Program – Estimated Land Available for Carbon Sequestration in the National Highway System," (May 2010), available at

XII. U.S. FHWA - John A. Volpe National Transportation Systems Center (Volpe Center). "Alternative Uses of Highway Right-of-Way: Accommodating Renewable Energy Technologies and Alternative Fuel Facilities," DRAFT (June, 2011)

XIII. Wakil, Abdul; Hanks, Dallas; and Whitesides, Ralph; "Freeways to Fuel – UDOT Pioneering the Future" (2007)

XIV. Wikipedia, "Carbon Sequestration," available at http://en.wikipedia.org/wiki/Carbon_sequestration (October, 2010)

XV. Wikipedia; "Biomass," available at http://en.wikipedia.org/wiki/Biomass

Wildlife Crossing

I. Carnivore Safe Passage, "Designing Effective Wildlife Crossing" (2007), available at http://www.carnivoresafepassage.org/design-crossing.htm

II. Clevenger, A. P., "Highways through habitats: The Banff Wildlife Crossings Project," Transportation Research News (2007)

III. Danby, D., "A Green Latticework," Worldchanging.com website (2004)

IV. Deer Crash Website, "DVCIC – National Animal-Vehicle Crash Fatality Data," available at www.deercrash.com/states/national_data.htm

V. Donaldson, Bridget M., "Use of highway underpasses by large mammals and other wildlife in Virginia and factors influencing their effectiveness" – Virginia Transportation Research Council (2005).

VI. Ecostudies Institute, "Road Ecology" (2005), available at http://www.ecoinst.org/ecostudies_pages/road_ecology.htm

VII. Hartmann, Maureen "An Evaluation of Wildlife Crossing Structure: Their Use and Effectiveness," Road-RIPorter - issue January/February 2002, volume 7#0, available at http://wildlandscpr.org/node/220

VIII. MountainNature.com, "Banff National Park's Crossing Structures" (2005), available at http://www.mountainnature.com/articles/CrossingStructures.htm

IX. Quinn, Jim; "Wildlife Crossing" presented on Road Ecology Seminar (2008)

X. Scott, B., "Florida panther deaths increase from collisions with vehicles," Florida Fish and Wildlife Conservation Commission (2007)

XI. Spellerberg, I. F., "Ecological Effects of roads and traffic: A literature review," Global Ecology and Biogeography (1998)

XII. The Humane Society of the United States, available at http://www.humanesociety.org

XIII. TxDOT, "TxDOT Cautions Motorists to Watch Out for Deer During the Season," October 2010, available at http://www.txdot.gov/news/045-2010.htm

XIV. U.S. Department of Transportation Federal Highway Administration (FHWA), "Wildlife-Vehicle Collision Reduction Study – Report to Congress," (August 2008)

XV. U.S. Department of Transportation Federal Highway Administration (FHWA), "Best Practices Manual: Wildlife Vehicle Collision Reduction Study – Chapter 7: Potential Funding Sources." (October, 2008)

XVI. USA Today, "Road fatalities involving animals," available at http://www.usatoday.com/news/nation/2010-11-30-deerkill30_ST_N.htm (November, 30th 2010)

XVII. Wikipedia, "Wildlife Crossing," available at http://en.wikipedia.org/wiki/Wildlife_crossing