Brownfields Redevelopment through Negotiation

by

Jayavel Sounderpandian

Department of Business
University of Wisconsin – Parkside
Kenosha, WI 53141-2000, USA

[Sounderp@uwp.edu]
Phone: (262) 595-2194
Fax: (262) 595-2680

and

Nancy Frank

Department of Urban Planning and Architecture
University of Wisconsin – Milwaukee
Milwaukee, WI 53201-0413, USA
[frankn@csd.uwm.edu]

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Jayavel Sounderpandian
University of Wisconsin – Parkside, Kenosha, WI 53141-2000, USA
[Sounderp@uwp.edu]
and
Nancy Frank
University of Wisconsin – Milwaukee, Milwaukee, WI 53201-0413, USA
[frankn@csd.uwm.edu]

Abstract

Brownfields are contaminated or suspected to be contaminated sites that have been abandoned or underutilized. Because of the serious economic and social damages that brownfields can cause to a neighborhood, governments all over the world have enacted laws governing brownfields redevelopment. Despite the laws, the excess cost of redevelopment over benefits and the uncertainties associated with both the costs and the benefits stall the redevelopment projects. Urged by the potential negative impacts of not cleaning up the sites, local governments take the initiative to redevelop sites by offering tax incentives and subsidies. The local government may also set up negotiations among its own representatives, the current owner of the site and prospective developers of the site. Although the literature on brownfields is vast, there are no techniques or guidelines available to a mediator who is assigned the task of conducting the negotiations. This paper presents a negotiation support system, which offers practical guidelines for a mediator to bring about a Pareto optimal settlement.

Keywords: Negotiation Support System, Brownfields Redevelopment, Pareto Optimality, Willingness To Pay, Contingent Contracts.

Introduction

The challenge of redeveloping contaminated sites has been complicated in recent years by additional costs and financial risks associated with environmental liability. Properties that once were homes to prosperous manufacturing and commercial activities possess a legacy of environmental contamination. Because of the environmental and health risks associated with such contamination, state and federal laws in the U.S. and some other countries require the owners of such properties to clean up the contamination. As a result, real estate investors are cautious in acquiring former industrial and commercial properties because the costs of cleaning up a site could easily exceed the value of the property (Page and Rabinowitz 1994).

Such properties have come to be known as *brownfields*. Brownfields are "abandoned, idled or under-utilized industrial and commercial sites where expansion or redevelopment is complicated by real or perceived environmental contamination" (U.S. EPA, 1997a). The U.S. General Accounting Office estimates that about 450,000 brownfield sites exist in the United States. State regulatory agencies have cataloged only a fraction of these sites. Costs of cleanup for these sites are unknown, but some estimates have been made. The U.S. Environmental Protection Agency (EPA) estimates costs in the $30 billion to $40 billion range (U.S. EPA, 1997a). One can imagine the size of the problem on a global scale. Although this paper is written in the context of the U.S., the concepts should be applicable in many countries.

Brownfields involve several uncertainties including:

- Uncertainty about the extent and seriousness of contamination on a site
- Uncertainty in investigation and cleanup costs

- Uncertainty in the length of time that will elapse between commencement of the investigation and the granting of permission to break ground for new construction
- Uncertainty in financing the costs
- Uncertainty in the buyer's long-term financial liability in the event some contamination remains following remediation.

Contaminants travel through soil and groundwater in three-dimensional space. The costs of cleanup depend on how far the contaminants have traveled, whether they are moving toward potential receptors (such as drinking water wells or surface waters), the toxicity and concentration of contaminants, and site characteristics that impede cleanup efforts. Environmental consultants are needed to collect data from soil and groundwater to model the flow of contaminants.

"Surprises" are not uncommon. A contaminant plume that initially appears to be fairly well localized on the site can turn out to have spread laterally, following old utility trenches or other "weak spots" in the underground geology. Such surprises bring the remediation to a temporary halt while environmental consultants conduct further investigations to ascertain the extent of the contamination and recommend a revised remediation plan. Meanwhile, the buyer suffers delays, which increases financing costs. Finally, purchasers are cognizant of the possibility of further surprises in the future. Although state voluntary cleanup programs have attempted to reduce the liability risks to parties who voluntarily cleanup contaminated brownfields, many uncertainties about future liability remain (Schworer 1997).

Brownfields reduce the tax base for the local government. In addition, they contribute to the continued decline of neighborhoods, or stand in the way of effective neighborhood revitalization. Consequently, local governments have taken a leading role in encouraging redevelopment of brownfields. Through a variety of public investments and incentives for private development, local governments have sought to lure private developers to clean up and redevelop brownfields. State and federal programs provide some assistance to local governments, but the decision to invest resources in a particular site is almost entirely a local decision made in negotiations with the current owner of the site and potential buyer(s) (Goldsmith and Taylor-Woodyard 1996).

In addition, in the U.S., no legal mechanism exists to insulate the developer, its financial backers, or other major participants in a brownfields redevelopment from possible liability to a third party who claims to be injured by contaminants that originate at a brownfield site. Given this insecurity, private investors are reluctant to overextend their financial exposure. In order to entice investors to invest in brownfields properties, local governments need to offer a package of financial and in-kind assistance that creates a level of comfort for the private sector to become involved in purchasing and cleaning up a site. Local governments have a variety of economic and community development tools at their disposal, including direct grants and loans, loan guarantees, tax incremental financing, technical assistance, acquisition assistance and insulation from liability (Sirota 1998). Local governments may also purchase insurance for a site (or self-insure and provide indemnification) to protect a purchaser from future liability. Deciding how much assistance to provide is a critical decision, one with few guidelines.

A variety of new approaches are beginning to be developed in the area of environmental decision-making (Mathis 1999), ranging from applications of decision analytic methods to consensus processes involving substantial stakeholder interaction

(Baxter, Eyles, and Elliott 1999; Caldart and Ashford 1999; Pellow 1999). Methods of mediation in brownfield real estate transactions are less developed, however. The purpose of this paper is to present a negotiation support system which offers practical guidelines for a mediator who might be entrusted with the task of conducting the negotiation among the three parties and arriving at a Pareto optimal settlement.

The Parties Involved

There are essentially three parties involved in the funding of a brownfield redevelopment project, namely, the current owner of the site, the prospective buyer (or developer or investor) and the government. The current owner often has statutory obligations to bear the cleanup costs. Many times, the current owner pleads poverty, or goes bankrupt. By virtue of recent statutes in the U.S., these obligations can persist even after the sale of the site and therefore the current owner may also be interested in paying for insurance against cost overruns and future obligations.

The second party is the prospective buyer, usually a real estate developer. The buyer is attracted by the future business prospects of the site. If the cleanup is completely successful and there is no stigma attached to the site, the prospects are good. Even better would be the prospects if more developments occur in the surrounding area. Indeed, most communities strive hard to remove the stigma through a complete development of the whole region.

Against the business prospects, the future owner faces risks in several forms. The area may not develop and a stigma may be attached to the site making the business prospects bad (Yount and Meyer 1994). Even worse would be the prospects if the cleanup is not done satisfactorily either because the contamination was more than estimated or because some funds meant for cleanup were not forthcoming. At times, depending upon the original contamination and the intended future use of the site, laws may permit certain types of partial cleanups. In this case, the chances of a stigma being attached to the site are much greater.

There can be more than one prospective buyer. But usually, depending upon the location, there will be just one buyer who is clearly willing to pay the most. For instance, in a busy urban location, retailers and fast food chains will show the most interest. In remote locations, warehouse builders will show the most interest. In special cases, the owner of an adjacent property who plans to expand shows the most interest. Because of these facts, a single buyer is assumed in this paper.

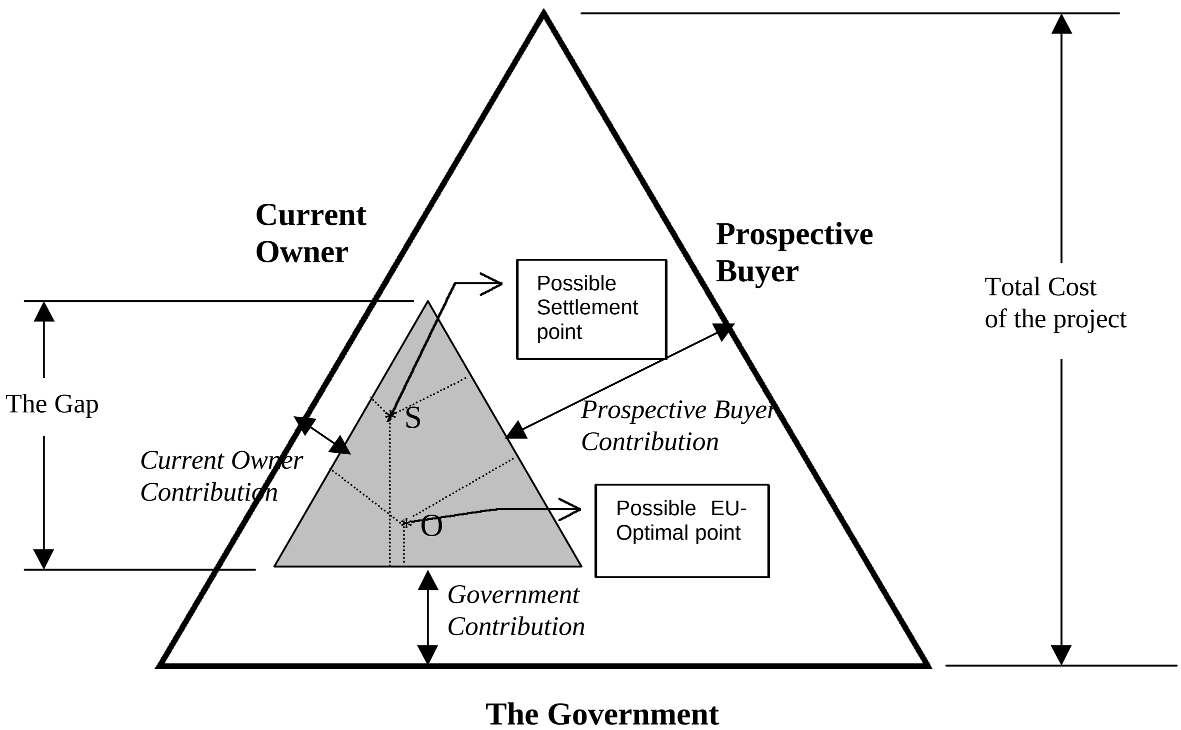
The final party involved is the government. The term government here includes local (city or county), state and federal governments. Most of the time, it is the local government that is most interested in seeing the site redeveloped, because the communities in the region stand to gain much from cleanup or lose much from not cleaning up. Cleanup improves the image of the area and attracts new businesses to the region. Property values increase and the tax revenues grow. Not cleaning up has the opposite effects.

Willingness To Pay

Suppose for a particular brownfield site, each of the three parties has expressed its Willingness-To-Pay (WTP) some amount toward the total cost of redevelopment. In Figure 1, the total funds required for a redevelopment project and the WTP of each of the three parties are shown. The figure makes use of the geometric fact that any point inside an equilateral triangle will have its distances to the three sides add up to a constant, which equals the height of the triangle. Let the height of the large triangle represent the total cost of the project. The three parties have been placed one on each side of this triangle. One may imagine (representatives of) the three parties sitting at the three sides of a triangular negotiation table. The distance between the outer triangle and the inner shaded triangle measured perpendicular to each side denotes the funds contributed by the party of that side. If the sum of the funds available from the three parties is sufficient to cover the total cost, then the project is undertaken and completed. All is well, and we don't have much to discuss here. When the funds are not sufficient, there is a gap equal to the height of the inner triangle, and some way of solving the problem is to be found. Among all the brownfield sites in the US, 97% experience gaps, and therefore remain as brownfields (Geltman 1997).

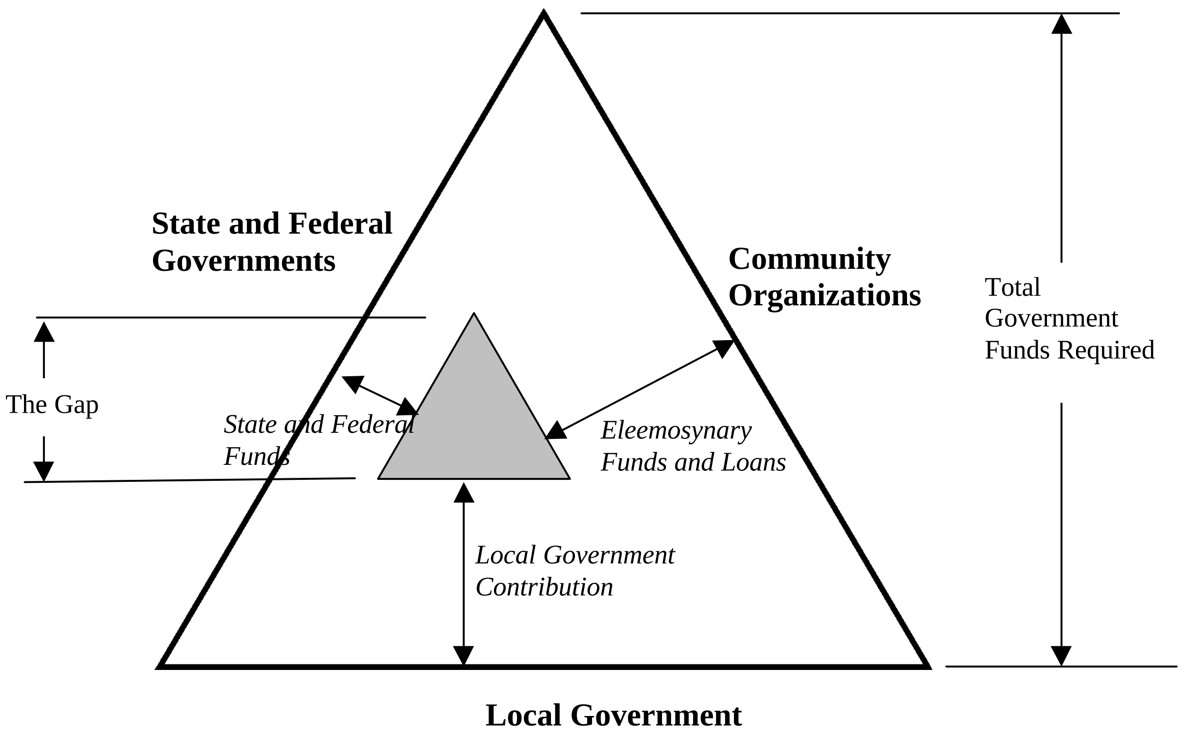
Suppose the three parties agree to participate in a negotiation, usually initiated by the local government. After a lengthy process they could arrive at a settlement point *S* in Figure 1. In this case the broken lines emanating from *S* show the additional funds that each of the three parties agreed to pay toward the project cost. The negotiation, then, is the process of finding the settlement point *S* that is agreeable to all three parties.

Figure 1. Willingness-To-Pay and the Gap



In Figure 1, the term Government is used to include local, state and federal governments. In addition, "forgivable" loans from public funds and contributions from non-profit community development organizations may also be used. Thus, the government's contribution seen in Figure 1 actually consists of local government funds, state or federal government funds and eleemosynary funds. This breakdown is shown in Figure 2.

Figure 2. Breakdown of Government Contributions and Loans



As the figure shows, there can be a gap here too. This gap refers to the additional public funds that need to be raised to meet the agreed amount of government contribution. For details of federal funds available, see U.S. EPA (1996). For an example of state funds available, see Philips and Rising (1997).

Because of the uncertainties in the project cost, the size of the outer triangle in Figure 1 is uncertain. One may represent this uncertainty in the figure by making the sides of the triangle blurred. If the project cost is uncertain, then the size of the gap is also uncertain, and therefore the inner triangle will also be blurred. The negotiation process has to cover the uncertainties as well. In other words, the process should finalize a risk sharing agreement through a contingent contract. A majority of the actual settlements in practice are indeed contingent contracts.

Notation and Data Collection

In this section, an Expected Utility (EU) model of the problem is developed. The model will be used to obtain EU-optimal solutions to different scenarios of the negotiation problem. The basic ideas of optimal contingent contracts under risk and other relevant concepts of group decision making can be found in Raiffa (1968, 1982).

Several different data need to be collected in preparation for the negotiation. The notations used for the data items are shown in Figure 3. Among the variables shown in Figure 3, the Optimal Payments are calculated using an optimization process to be explained later. The rest of the quantities are data that need to be collected. In addition to the variables listed in the table, we shall use the notation u^1, u^2 and u^3 to denote the utility functions of the three parties.

Figure 3. Notations Used and Data Organization

Insurance Status: ____________________

Scenario	Estimated Cleanup Cost	**Current Owner**				**Prospective Buyer**				**Government**			
		Subjective Probability	Estimated Income	Optimal payment	Willingness to Pay	Subjective Probability	Estimated Income	Optimal payment	Willingness to Pay	Subjective Probability	Estimated Income	Optimal payment	Willingness to Pay
1	X_1	p_1^1	y_1^1	x_1^1	w_1^1	p_1^2	y_1^2	x_1^2	w_1^2	p_1^3	y_1^3	x_1^3	w_1^3
2	X_2	p_2^1	y_2^1	x_2^1	w_2^1	p_2^2	y_2^2	x_2^2	w_2^2	p_2^3	y_2^3	x_2^3	w_2^3
. . .													
n	X_n	p_n^1	y_n^1	x_n^1	w_n^1	p_n^2	y_n^2	x_n^2	w_n^2	p_n^3	y_n^3	x_n^3	w_n^3

At the top of the table we have the “Insurance Status” which refers to what types of insurance contracts have been assumed as purchased. All the data in the table are for this status only. Similar data needs to be collected for each insurance status, i.e., one table for each status. The insurance underwriters could be private companies or the local government itself. It is quite common for the local government to resort to self-insurance.

The scenarios in the first column refer to different outcomes of the total cleanup cost under the insurance status assumed. The Estimated Cleanup Cost is usually available from the consulting firm that is hired to conduct contamination analysis and summarize the needed cleanup efforts. Strictly speaking, the cost is continuously distributed, but the practice is for the consultants to provide discrete cost estimates corresponding to three or four discrete probable scenarios of the extent of the contamination. We thus have one row in the table for each probable scenario. In each row, Subjective Probability and WTP are gathered through interviews. (A good thing about the optimization method described here is that it allows different subjective probabilities for each scenario.) Estimated Incomes are difficult to assess. In the case of the Current Owner, this will be the dollar value of the relief from future liabilities. Often, the current owner would have declared bankruptcy and might be delinquent in tax payments. Thus, the “Income” could include waiver of back taxes.

In the case of the Prospective Buyer, the Estimated Income will be the net present value of additional profits from future business at the site or the market value of the property when cleanup is completed. This value will be influenced by the tax benefits and subsidies provided by the government as a result of the negotiation process itself.

Thus the figures may have to be dynamically updated. There are no laws or covenants that force a prospective buyer to disclose their business plan and thus their Estimated Income. At times, litigation occurs, and the buyer discloses more information. In the absence of litigation, the buyer can still be persuaded by the prospects of arriving at a Pareto optimal settlement.

In the case of the government, the income occurs in several tangible and intangible ways such as new jobs created, additional tax revenues, increased property values and better chances of economic growth in the community. Except the increase in property values, which is difficult to estimate, all the other estimations are easy and routine.

To estimate the increase in property values, we suggest the use of a *hedonic pricing model* (see Rosen 1974, Lucas 1975). For details of a practical application of the model, see Brookshire et al. (1982). For some technical pitfalls in using the model, see Brown and Rosen (1982). In order not to digress too far, our discussion of hedonic pricing models will be kept simple.

In its simplest form, a hedonic pricing model uses multiple regression. Suppose the data on the values of properties that lie close to a brownfield and those that are away has been collected. A multiple regression of the value against relevant variables such as the age of the property, built area, and type of construction and an indicator variable (0 = near brownfield; 1 = away from brownfields) would yield a regression equation

$$V = b_0 + \sum_{i=1}^{k-1} b_i x_i + b_k x_k$$

where V is the value of the property; b_0, b_1, …, b_k are the regression coefficients; x_1, x_2, …, x_{k-1} are the scores on relevant variables; and x_k is the indicator variable. Then, b_k is an estimate of the additional value that a property derives by being away from brownfields. This implies that b_k is also the increase in the value of a property when a brownfield is cleaned up. There are several refinements that can be made on the method, such as using a multiplicative model, but they are not discussed here.

The utility functions u^1, u^2 and u^3 are to be estimated through interviews. Much detail on different forms of utility functions and how to assess them can be found in Keeney and Raiffa (1976). Among the different types of utility functions we choose the exponential form since it avoids the need for data on current wealth of the three parties. In addition, the exponential utility has a few other desirable technical properties (Pratt 1964; Bell 1988, 1995). We shall go with the exponential function

$$u^i = 1 - e^{(\frac{-x}{R^i})}$$

where x is the net income to the party i and R^i is its *risk tolerance*. Risk tolerance is easily estimated by asking the subject at most how much he/she is willing to bet in a 50-50 gamble of losing the bet amount or winning twice the bet amount (Clemen 1996). Twice the bet amount, then, is approximately the risk tolerance of the subject. This approximation is good enough for the negotiation problem.

During our conversations with a Midwest city official who was in charge of the city's several brownfield redevelopment projects, we explained what a utility function is and how the above process for estimating risk tolerances works. He understood the concepts quickly. We then asked him what would be the city's risk tolerance if he represented the city in a negotiation. He turned back and asked us, "What are the risk tolerances of the other two parties, the current owner and the prospective buyer?" We said, "Let's say they are both $100,000." He still asked, "What do you think the city's risk tolerance ought to be?" We said, "Considering that the city government's risks are shared by more people than in the case of the other two parties, we think it should be $400,000." He replied, "Although the risk is shared by more people, a city official comes under very close public scrutiny. Any bad risk can become quite notorious. If the other parties have $100,000 tolerance, I may be persuaded to $200,000, but not more." To us this conversation is an encouraging sign that this method of utility assessment can be validly used in practical situations.

Using the suggested methods and techniques, let us assume that all the data have been gathered.

The EU Optimization Model

We shall assume that a mediator has been assigned the task of conducting the analysis and preparing for the negotiation. Referring to the notations in Figure 3, we note that the utility of a particular scenario *j* to party *i* is given by

$$u_j^i(y_j^i - x_j^i)$$

Taking the (subjective) expectation of this utility over all scenarios, we get the expected utility as

$$Eu^i = \sum_{j=1}^{n} p_j^i u_j^i (y_j^i - x_j^i)$$

where *n* is the total number of possible scenarios.

The mediator may assign the weights $\lambda^1, \lambda^2, \lambda^3$ to the three parties' expected utilities and maximize the sum $\sum_1^3 \lambda^i Eu^i$. The weights may be normalized to add to 1. Assigning a larger λ to a party favors that party and will result in smaller payment by that party. Therefore, what λ values are assigned to the different parties is a sensitive issue.

Based on our interviews with government officials and consultants, we suggest a value of 0.4 for the government and 0.3 for the other two parties. The mediator may change these values as the situation demands. For example, the mediator might consider the financial ability of the parties to shoulder a larger share of the costs. Or, in the case of a current owner who had intentionally contaminated a site, a smaller may be ethically appropriate.

The constraints in the optimization problem are:

1. The sum of all the optimal payments in each scenario should be greater than or equal to the total cleanup cost under that scenario.
2. The optimal payment of each party in each scenario should be greater than or equal to the party's WTP under that scenario.

Referring to Figure 1, the first constraint ensures that the gap will be zero and the second ensures that the optimal point *O* will lie inside the inner triangle.

The optimization problem thus becomes:

Maximize $\sum_{1}^{3} l^{i} Eu^{i}$

Subject to

$$\sum_{i=1}^{3} x_j^i \geq X_j \quad \text{for } j = 1, 2, \ldots, n$$

$$x_j^i \geq w_j^i \quad \text{for } i = 1, 2, 3;\ j = 1, 2, \ldots, n.$$

Since the constraints in this optimization problem are linear, the feasible region is convex. Since the value of the objective function strictly increases as any x^i_j decreases, the solution to the problem will be Pareto optimal. Indeed, by solving the problem for various combinations of the λ values, one can obtain the Pareto Frontier.

The above problem needs to be solved for each insurance status, and because the data will change as the negotiation proceeds, the whole process needs to be repeated as dictated by the negotiation process. Fortunately, the Solver macro in Microsoft Excel easily solves the above problem. A Pentium III 500 MHz computer takes less than a second to solve a problem with as many as ten scenarios. A mediator who is not familiar with optimization problems can be easily trained to solve the problem using Excel. The spreadsheet preparation and the Solver settings are shown in Figure 4. The monetary data shown in the figure are in thousands of US dollars. The cleanup costs and probabilities are for an actual, relatively small project from a mid-size Midwest city, as narrated by the mayor of that city during an interview by the authors. The Estimated Income and WTP values are hypothetical. No insurance has been assumed. The spreadsheet uses exponential utilities with a risk tolerance of 400 for the government and 100 for the other two parties. The sensitivity analysis report produced by the Solver is shown in Figure 5. The Lagrangian multipliers and the gradients in the report are useful, as described below.

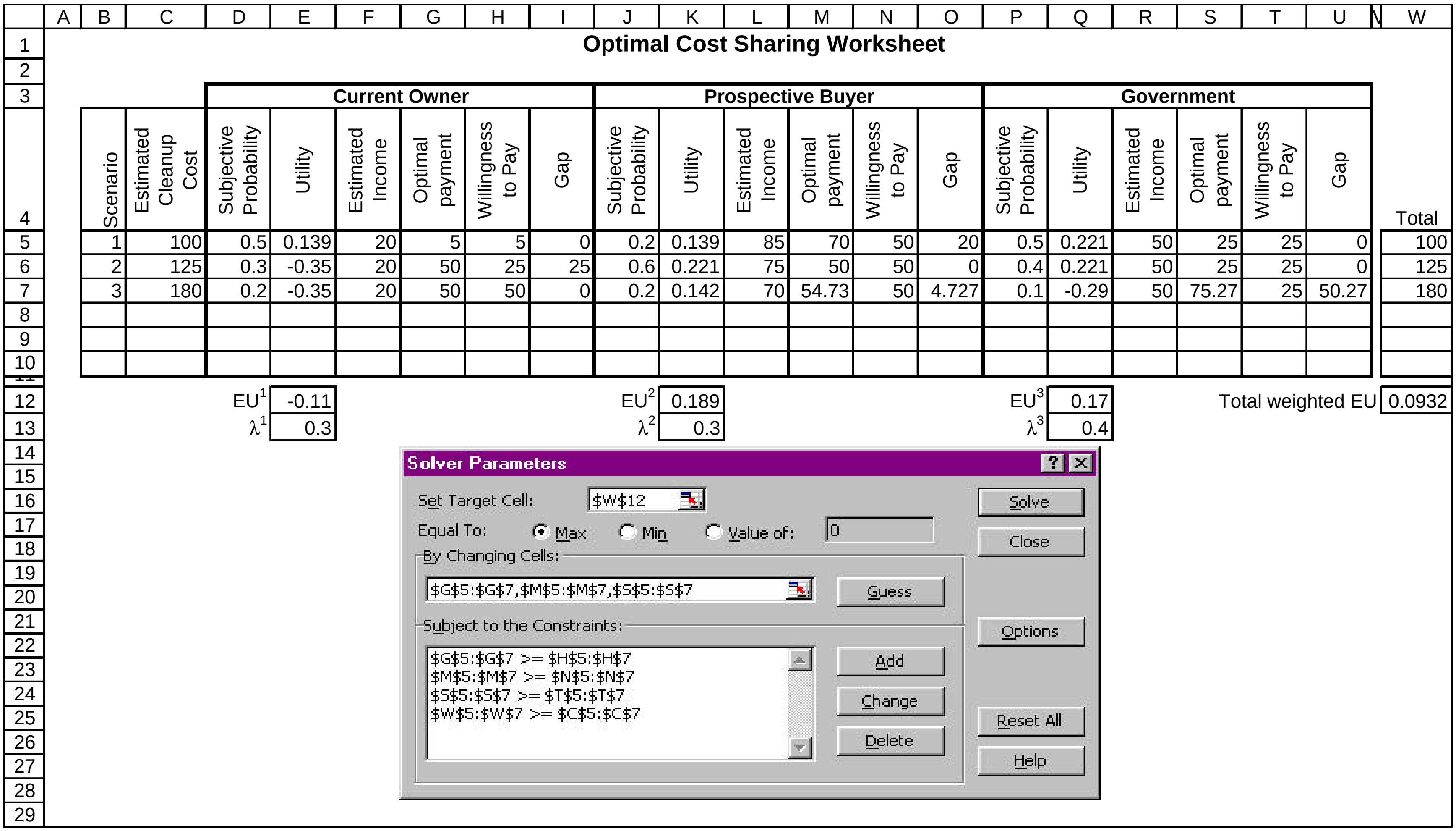
Mediator's Choices

When the optimization problem is solved for each insurance status, the mediator can prepare a table summarizing all the solutions in the format shown in Figure 6. The Total Weighted EU column shows the overall desirability of a choice disregarding the gaps. The gaps are the differences between the optimal settlement values x^i_j and the corresponding WTP values w^i_j. The Lagrangian multipliers indicate the severity of the gaps. For example, for the case displayed in Figures 4, 5 and 6, the largest magnitude of the multiplier (0.00121) occurs for Scenario 2 constraint and the amount of the gap in that scenario (25) is also substantial. Thus, that scenario is going to need a lot of persuasion of the three parties to increase their WTP's.

The reduced gradients shown in Figure 5 are a measure of how acceptable the WTP's are. A non-zero value indicates that the corresponding WTP is large enough. A zero indicates that the party should be asked to pay more than the WTP to close the gap.

Each insurance status in Figure 6 is, in effect, a choice that the mediator has for presentation at the negotiation meeting. Using the summary in the figure, the mediator can select one or two best choices by giving proper consideration for the total EU, the gaps and their severities. During the negotiation, the parties should be apprised about the utility functions assumed, the λ values used, the estimated incomes, the gaps in each scenario and the EU-optimal solution for each scenario. A spreadsheet printout as in Figure 4 would do well for this purpose.

Figure 4. Spreadsheet and Solver settings



Optimal Cost Sharing Worksheet

		Current Owner						Prospective Buyer						Government						
Scenario	Estimated Cleanup Cost	Subjective Probability	Utility	Estimated Income	Optimal payment	Willingness to Pay	Gap	Subjective Probability	Utility	Estimated Income	Optimal payment	Willingness to Pay	Gap	Subjective Probability	Utility	Estimated Income	Optimal payment	Willingness to Pay	Gap	Total
1	100	0.5	0.139	20	5	5	0	0.2	0.139	85	70	50	20	0.5	0.221	50	25	25	0	100
2	125	0.3	-0.35	20	50	25	25	0.6	0.221	75	50	50	0	0.4	0.221	50	25	25	0	125
3	180	0.2	-0.35	20	50	50	0	0.2	0.142	70	54.73	50	4.727	0.1	-0.29	50	75.27	25	50.27	180

EU^1	-0.11	EU^2	0.189	EU^3	0.17	Total weighted EU	0.0932
λ^1	0.3	λ^2	0.3	λ^3	0.4		

Figure 5. Sensitivity Analysis Report from Excel Solver

Microsoft Excel 8.0a Sensitivity Report
Worksheet: [FUR 9 Fig 4.xls]Sheet1
Report Created: 5/25/99 2:33:58 AM

Adjustable Cells

Cell	Name	Final Value	Reduced Gradient
G5	Optimal payment	5	-0.000774637
G6	Optimal payment	50	0
G7	Optimal payment	50	-0.0002949
M5	Optimal payment	70	0
M6	Optimal payment	50	-0.000186968
M7	Optimal payment	54.72674987	0
S5	Optimal payment	25	-0.001041177
S6	Optimal payment	25	-3.12082E-05
S7	Optimal payment	75.27325013	0

Constraints

Cell	Name	Final Value	Lagrange Multiplier
W5	Total	100	-0.000516425
W6	Total	125	-0.001214873
W7	Total	180	-0.000515016

Figure 6. Mediator's Choices

Insurance Status	Total Weighted EU	Scenario	Gaps in the Funds: Current Owner	Prosp. Buyer	Govern-ment	Total	Lagrangian Multiplier
1	0.09322	1	0	20	0	20	-0.00052
		2	25	0	0	25	-0.00121
		3	0	4.7267	50.2733	55	-0.00052
2		1					
		2					
		3					
m		1					
		2					
		3					

The table in Figure 6 forms the basis for the contingent contract. Since the actual costs are continuously distributed, there should be a further understanding that for cost values falling between two scenarios, interpolation will be used. This concludes the preparatory work that the mediator has to do before calling the negotiation meeting.

The Negotiation

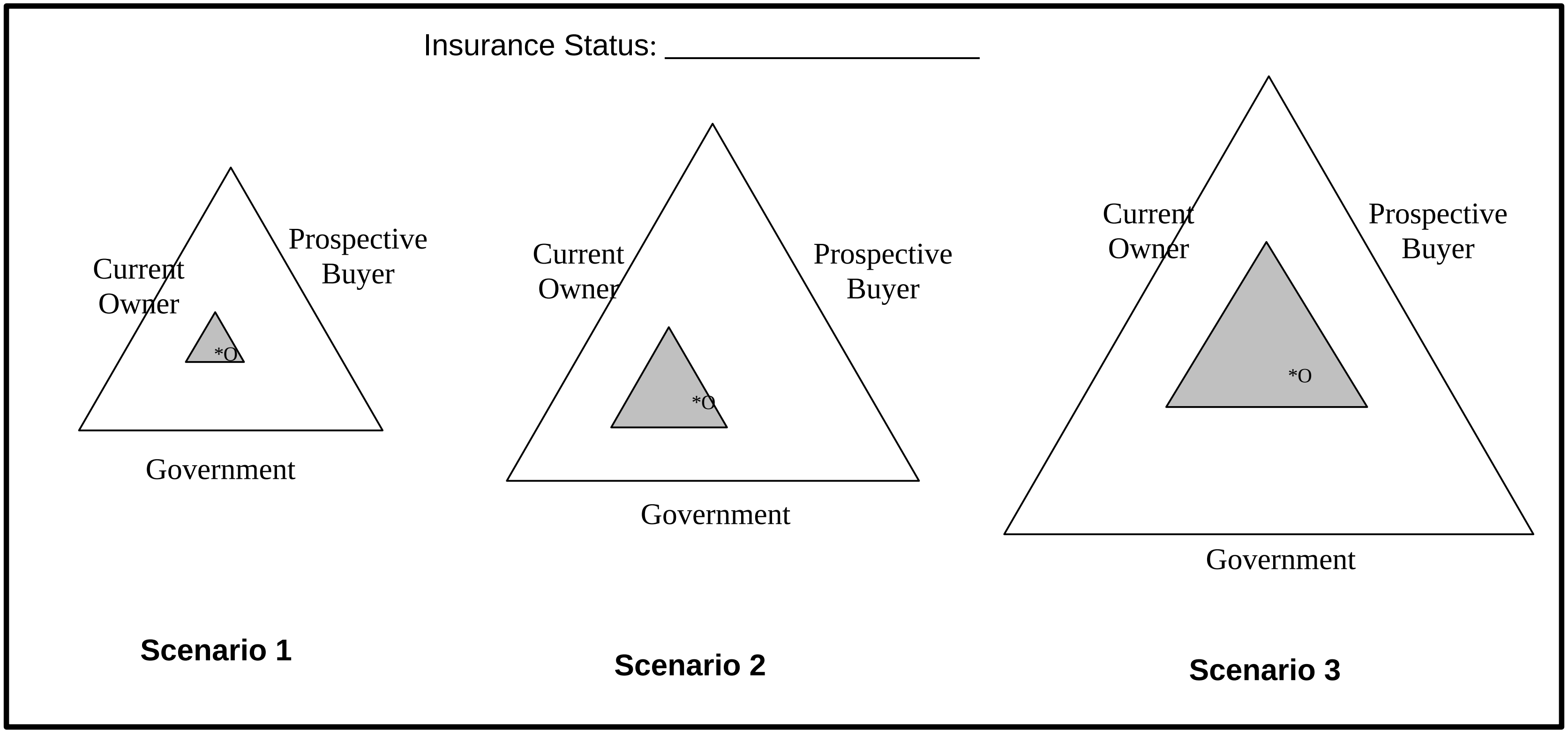
According to the government officials we interviewed, getting the prospective buyer to the negotiation table is a formidable task. A buyer cares more about the market value of the site than other matters, since other non-contaminated sites are almost always available. Through incentives such as tax credits and loan guarantees, the local governments can induce the buyer to come to the negotiation table and even pay more than the originally announced WTP.

The current owner usually obliges to attend negotiation meetings due to looming legal liabilities. Most of the time, the owner pleads poverty or declares bankruptcy and thus tries to avoid paying legally sanctioned penalties. Also, because of the stigma attached to contaminators, the owner even avoids revealing his/her/its identity. The owner comes to the negotiation table primarily for waivers of the liabilities.

The government representatives will be concerned with the accountability of their decisions, the public visibility of downside risk and possible reversion of a site to brownfield status due to fresh or non-remedied contamination. They therefore tend to be more risk averse than they should be. But they are always interested in getting rid of brownfields, and are willing to negotiate.

During the negotiation, the mediator should present the selected alternative(s) using spreadsheet printouts as in Figure 4. In addition, it is preferable to use a visual chart similar to the one shown in Figure 7. The chart shows for each scenario the cost of the cleanup represented by the outer triangles, the gaps represented by the inner triangles and the optimal point *O* recommended by weighted EU optimization. For each gap in the optimal solution, the parties need to discuss and find ways to persuade one another to increase their WTP.

Figure 7. Contingent Contract Scenarios for Presentation to the Three Parties



The most direct way to influence a party to increase their WTP is to increase their EU in selected scenarios. The Current Owner can be influenced by indemnifying covenants under certain scenarios. The Prospective Buyer can be influenced by tax subsidies and forgivable loans. The government may be able to raise more funds by highlighting to the public the expected increase in property values.

Suppose after a round of negotiation, the WTP values have been revised. It is now time to find the next optimal solution. The data entry may take a few minutes, but the solution process takes only a fraction of a second. Thus, with the help of a laptop computer the mediator can efficiently conduct the iterations of the negotiation process. We recommend that the iterative calculations of optimal solutions be carried out in the presence of everyone, so as to increase the trust among the parties and speed up the process of arriving at a settlement.

Through successive iterations, the goal of the negotiation is to find for each scenario the settlement point *S* at which the inner triangle converges and vanishes. The contingent contract that the parties agree upon follows immediately from the settlements for the different scenarios. For instance, if the solution shown in Figure 4 is accepted, then the contingent contract will look like Figure 8. A further agreement could be that if the cleanup cost is in between two different scenarios, the parties will prorate their payments.

Figure 8. A Contingent Contract

		Payment from		
Scenario	Estimated Cleanup Cost	Current Owner	Prosp. Buyer	Govern-ment
1	$ 100,000	$ 5,000	$ 70,000	$ 25,000
2	$ 125,000	$ 50,000	$ 50,000	$ 25,000
3	$ 180,000	$ 50,000	$ 54,727	$ 75,273

Note that the payment from the Prospective Buyer decreases as we go from Scenario 1 to Scenario 2. This occurs because in Scenario 2, the Current Owner's legal liability is higher and he is therefore willing to pay more. Also, in Scenario 2, there may be a stigma attached to the site, which could reduce the Estimated Income for the Prospective Buyer. The EU-optimal result is a reduced payment for the buyer although the cleanup cost was bigger. The chances of this fact coming to the buyer's knowledge are greater when a tripartite negotiation takes place.

Conclusion

We have presented a negotiation support system that provides practical guidelines for a mediator to conduct brownfield redevelopment negotiations. The optimization part of the process has been simplified through the use of spreadsheets. But it must be noted that the method still requires considerable amount of data collection and analysis. The mediator has to continually look at the computer solutions and sensitivity reports to re-formulate the scenarios to be presented to the three parties. Currently, practitioners agree that negotiations rarely take place and suboptimal decisions are being made. Hopefully, through negotiations along the guidelines suggested in this paper, better decisions that are Pareto optimal would be made and previously stalled redevelopment projects would be reactivated and completed.

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