Value of incorporating flexibility in lab buildings: A Real Options Approach

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ABSTRACT

This thesis investigates flexibilities in commercial lab buildings with the help of the real options theory. The qualitative component of the thesis explores the development of the lab building as a building typology and its relationship to economic value creation for developers. It also investigates various strategies employed by developers during the design and development of lab buildings to hedge against the downside risk. The quantitative component builds upon that hypothetical lab building development case and creates a Real Options case as a framework for applying and valuing flexibility in this complex building type. Through this demonstration, valuation of flexibility employed in the current practice is derived.

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Finally, I would like to dedicate this thesis to my family: My parents for their love and unwavering support through thick and thin. To my wife Deepa, for her love, friendship and her partnership in all of life's adventures. To my son Neel, for making everything worthwhile.

Kartik

Table of Contents

List of Figures

1 Chapter 1: Introduction

1.1 Background & Objective

The United States is a leader in the Science and Technology field. Higher educational institutions, non-profit research institutes and for-profit corporations conduct research and Development (R&D) in this field. Primary research is conducted in the highly controlled environments of labs where experiments are conducted, prototypes are tested and chemical compounds and therapies are formulated. Research and Development in life sciences have been crucial in eliminating life-threatening diseases, giving rise to a thriving and cutting-edge life sciences industry in the US.

Human & environmental safety along with concerns for the maintenance of sterile environments has ensured that life sciences research is done in a controlled environment. These highly restrained experiments have given rise to a very specific building type – Lab Buildings, which have very specific planning and design requirements with respect to ventilation, temperature, humidity, particulate matter control, building utility and energy. These requirements make lab buildings one of the most expensive buildings to build with gross per sft cost of lab buildings expected to be upwards of $1000 per sft in some of the biotech and life-science focused markets. High capital costs involved with these buildings ensures that only developers with expertise in this building type are involved in commercial lab building development. High development costs aligned with the requirement of the qualified workforce for research has given rise to the development of commercial lab buildings in highly concentrated clusters around agglomeration economies. The larger objective of this thesis is to understand how value is created in the development of these lab buildings. What kind of role does flexibility play to eventually make the development of this building type more accessible to the life sciences industry to further the advances in human and environmental health?

Real Options theory is a rigorous and quantitative way to model the value of an investment decision by developing options to mitigate the effects of uncertainty inherent in these investment decisions. Real options theory has been successfully incorporated in the infrastructure development and natural resource extraction industry but has not found wide spread use in the real estate industry. The real options approach adds value to a project by providing developers with flexibility to minimize the downside risk or maximize upside potential as conditions change from prior expectations. Real estate developers have relied on their intuition and judgment owing to the complexity and quantitative rigor required to incorporate real options theory in practice. Previous academic research has promoted the real options theory in real estate development but the research has mainly focused on mainstream commercial projects with options to expand, abandon or defer.

This research intends to analyze the development of the lab building through the lenses of the real options theory. The lab building is distinctly characterized by high development costs compared to other building types keeping the residual land value constant. This high level of investment in the building is dictated by the specific requirements of health, safety and research standards of the intended use.

Currently the flexibility being incorporated in lab buildings still assumes the full build-out of the project. The flexibility options include the ability to change the plan configuration of lab on a floor to suit different research needs by incorporating movable and adaptable lab benches, plug and play infrastructure. My research motivations are to understand if there is any value in incorporating structural, physical or programmatic flexibility at the onset of the project before the building is built.

Within this context I would like to examine the following questions for this research thesis.

a. What are the most critical factors for the optimal performance of the lab buildings that should be part of the deterministic model at the onset?
b. What kinds of uncertainties effect the development of lab buildings?
c. What is the value of developing optionality so that uncertainties in the context of lab buildings can be dampened?
d. How is "flexibility" defined in the context of lab building developments?
e. How will future lab buildings incorporate flexibility to respond to the uncertainties e.g. changes in market conditions, changes in the uses or change in the research direction requiring change in the building program?
f. Considering the distinct nature of lab building development, what is the value of incorporated flexibility in R&D building development?

1.2 Methodology

This research is a combination of qualitative as well as quantitative analysis. Qualitative research involves literature survey as well as interviews with key protagonists and their agencies to understand the above mentioned research questions. For the purposes of the qualitative analysis an attempt was made to interview the full spectrum of agencies involved in the development of the lab buildings.

Simultaneous to this qualitative analysis, quantitative basis for research is developed. Existing development costs and resultant cash flows are utilized to develop deterministic model of R&D building. Qualitative analysis and interviews help in identifying uncertainties of critical importance to different protagonists. These could be market uncertainties. These uncertainties are utilized to develop decision triggers. A combination of these decision triggers will be run through simulation to arrive at the optimal valuation of the NPV. Valuation conclusions are developed based on the results of the simulations and uncertainties incorporated in the model.

1.3 Literature Review Summary

Two types of literature were reviewed for this research. First, the literature about R&D lab building development was mainly reviewed from the trade publications and planning guides published by the organizations that engaged the architecture & engineering of these building types. Review of the research carried out by practicing professionals about the recent current & emerging trends in development of the lab building development provides a deep insight into the issues facing the industry. The analysis of this research is presented in Chapter 2.

Second, the literature on the Study of Real Options and its application in real estate were reviewed. Brealey Myers Allen (2014) provides foundational understanding of Options and Real Options. Simple valuation method, binomial method and Black Sholes Formula were reviewed for the option valuation. Real Options and types of real options were reviewed to develop the understanding of the value of flexibility inherent in the capital investment decisions in corporate finance.

Geltner et al. (2007) provided an introduction to the real options in real estate development. Call option model of land value, binomial model and Samuelson-McKean formula were reviewed to understand the important distinction between various models. A Binomial model was used to value finite lived real options and the Samuelson McKean formula was applied to value real options that are continuous in time, perpetual or existing forever.

As described in Chapter 3, leasing option in a lab building provides the option holder/developer with a flexibility to lease the vacant space to maximize his investment in the building. At an optimal time, this investment enhances the value of the lab building by either investment of more capital in the form of appropriate utilities for the next tenant or demand to tenants to contribute towards the investment in utilities. Grenadier (1995a), (1995b), (1995c), (2005) provides an insight into the valuation of the variety of real estate leases by using an intuitive and simple framework of leasing as a mechanism for separation of ownership from use, with lessee receiving the benefits of the use and lessor receiving the value of the lease payments plus the residual value of the asset. Grenadier (1994) is reviewed to understand the model of inter-temporal tenant mix strategy in an environment of demand uncertainty, cost of adjustments and tenant interaction effects. Although not directly related, Grenadier (1994) provides additional insights into the dynamic flexibility emanating from sequence of underlying options as well as on the initially optimal portfolio of tenants.

2 Lab Buildings in Research and Development

2.1 Science and Technology in US and Future Trends

Research and development in sciences has allowed us to solve some of the most critical challenges by increasing our knowledge and understanding of the world. Today, this innovation is improbable without proper funding and hence funding associated with any research endeavors is a distinct indicator of the future trends in that research area. Battelle's 2014 Global R&D Funding Forecast projected United States to be the world's largest R&D investor with projected $465 Billion spending in 2014, which represents almost 2.8% of the US GDP. Out of the total share of the R&D activity in US, private sector accounts for almost three quarters of the US research activity. Excluding federal R&D funding that flows through the private sector via grants, internal R&D cost recovery and other mechanisms, industry R&D funding was projected to reach $307.5 billion in 2014. A major portion of this funding is in the life sciences, pharmaceutical and biotech sectors, which makes its way down to investment in cutting edge lab building facilities where the actual drug discovery research and production is mainly carried out. This thesis focuses on the development of commercial lab buildings that are leased out to the private or institutional tenants who are involved in this life sciences, biotech and pharmaceutical research.

2.2 Main Protagonists and Their Motivations

There are four key participants in the development of Lab Buildings

1. University and Research institutions
2. Commercial Biotech and Pharmaceutical Companies
3. Private Real Estate developers
4. Government Institutions

These four participants have their own motivations to develop or lease lab buildings in keeping with their overall long-term goals. This thesis primarily focuses on private real estate developers who are in the business of developing commercial lab buildings for potential tenants, which could come from any of the other three participants.

Based on their goals, flexibility could have different meaning for each of the above participants. University and academic institutions operate on limited capital resources based on their endowments. They want their lab buildings to be teaching labs as well as to serve academic researchers who participate in grant-funded research. These goals might require the university lab buildings to be able to adapt to teach cellular biology and portrait painting, or be able to reconfigured to support team based research led by a principal investigator. Hence academic lab is able to create value for its institution when it is able to support multiple sciences and user groups with its reconfigurable space, shared infrastructure.

Biotech and Pharmaceutical firm's research activities are mainly geared towards developing new drugs that can be introduced in the market to generate attractive returns for their shareholders. For these firms, the flexibility is in being able to expand from the early stages of drug discovery research to prototype these drugs ready for a market based on FDA guidelines. They need their lab spaces to be easily adaptable from research space to targeted agile bio manufacturing space based on Good Manufacturing Practices (GMP). They also need this space to be easily reconfigurable as the direction of their sciences changes. Suboptimal lab space or research and production facilities can affect the product cycle adversely if the FDA disqualifies it.

Private developers in lab building space and asset markets play a critical role by filling in the gap between owning the facility and leasing the facility. By treating lab space as an asset class, they provide an essential service to all the other participants. They take on the risk of owning, developing, maintaining and renting lab space for annual rental income. Divesting the ownership and the maintenance of the lab facility allows other participants to focus on their core activities of conducting research for academic or product development purposes.

Owner occupied lab buildings for biotech and pharmaceutical corporations are seen as sunk costs with optimal flexibility. As corporations know their area of science and building a lab is similar to building a plant, the building is designed with certain flexibility but the overall use is predetermined. Lab buildings hold strategic value for academic institutions and private developers as they hold these facilities for the long term—for academic purposes and annual rental income respectively. For private developers, the lab building needs to be generic with high flexibility to attract a wide array of tenants from pharmaceutical and biotech companies to academic institutions. Hence private developers should value flexibility more than private owner-occupied lab buildings. These private developer led commercial lab buildings are the focus of this research.

2.3 Lab Building Type

The Lab building type is highly dependent on the kind of scientific research that is conducted within. Different sciences have different kinds of space and infrastructure requirements, but broadly the following lab types define these lab buildings:

- Chemistry Lab
- Biology Lab
- Animal care Facility
- Biosafety Level Labs
- Good Manufacturing Practice (GMP) Production Facilities

- Advanced Physical Science Research facilities
- Nanotechnology Research Facilities

The lab building type is also dependent on the kind of users for these lab facilities. Academic users who are funded by research grants and philanthropic endowments are also involved in teaching and practical application in addition to furthering research. These academic lab buildings have higher occupancy levels and are designed for long-term use and lifetime of discovery. Hence these lab buildings are utilities heavy and have high level of redundancy. The researchers in these labs tend to use equal amount of time between their office, hospital, lab space and classroom hence these buildings have lower lab benches per researcher.

Commercial users of labs on the other hand are focused both on discovery and bringing these discoveries to the market to make profits for their shareholders. Because of the competitive marketplace, these companies are also focused on creating an attractive environment for their employees and researchers to retain and attract the talent. Hence commercial users of the space pay special attention to amenities they can provide within their lab buildings. On the functional side, these commercial lab buildings tend to have an appropriate amount of office space nearby to foster collaboration among all disciplines and to support lab operations themselves. These commercial users tend to use their space more efficiently but overall there is more lab space per researcher than academic research labs. These lab facilities are also actively managed to address, churn and maintain facilities so as to minimize any downtime for a specific researcher.

In addition, start up companies and companies in the earlier discovery stages tend to preserve their capital for research purposes over spending it on facilities. These commercial companies tend to either lease spaces in existing commercial lab buildings or partially fund build out with landlord capital that is financed through base rent. Since the developer takes the risk of developing and owning the building even if the original tenants leave, these lab buildings are designed to be generic to allow one or multiple tenants to cover a wide variety of uses and sciences in the building. The developer owns the buildings and the fixed equipment installed in the building. Developers might be able to accommodate any special requirements at the tenants expense with a lease provision that this equipment will be removed at the end of the lease if the equipment/ requirement doesn't offer the developer any long-term value.

2.4 Approach to Creating Value:

In commercial real estate, value is created for a developer/investor when he is able to obtain a higher valued property at a lower cost either by developing a property on a land parcel or acquiring a property from the seller. Property value is the function of the amount of future rents the property can generate as well as the appreciation in the price that the property will fetch when it is sold in the future. Hence, a developer is able to create value for himself and his investors when he is able to control a property that provides steady rent cash flows in the future and which will sell at a higher price than what was paid for to control that property.

Based on the above concept of creating value this research is mainly focused on the commercial lab buildings & their developers that serve the life sciences companies from start up phase till they are established in the market. Matured companies tend to move their production to commercially viable and profit maximizing locations and their research to locations with collaborative potential with other companies and institutions. These matured companies also tend to own and operate their own real estate so as to create long-term value for their investors by developing assets. Commercial lab developers serve an important function by filling in the gap for companies that are at early stages of their growth cycle and that tend to rent their lab facilities instead of owning it so that they can focus on their research and product development.

In competitive real estate market, commercial lab building developers try to create value for their investment by ensuring that the amount of capital invested in a lab building is preserved and the building is fully utilized to its financial potential without any further capital investment. As lab tenants have diverse requirements for infrastructure systems, developers ensure that the lab building is flexible and is planned to accommodate future tenant requirements. The lab building is built with a capacity to accommodate future infrastructure. However the actual infrastructure is not placed so that flexibility on capital outlay can be maintained depending on specific tenant requirements. As the building is leased, developers spend capital on only generic infrastructure required by the lab tenant with specific requirements incorporated at the tenant's expense. Any previously planned infrastructure systems not required by the tenant are not incorporated in the lab building and they can be cost savings to the developer.

Developers prefer their lab buildings to be as generic as possible so that they can serve diverse tenant types in the future as building goes through multiple leasing cycles. Once this infrastructure is placed in the building as per initial tenant requirements, developers want to ensure that this infrastructure could be utilized for all the future tenants without any substantial addition in subsequent leasing cycles.

Developers offer tenant improvement allowance to tenants to build out the space. Magnitude of this allowance is typically dictated by the lab space market and building condition. This allowance is typically higher than allowance for typical office building because of the nature of improvements involved. Developers will pay for a major portion of the cost of building out the tenant space but the tenant funds any specific requirements. Developers amortize the cost of the allowance to tenants in the rents charged over the period of the lease. As higher tenant improvement allowance translate into a higher rent for tenants, they are incentivized to keep the allowance as low as possible. A tenant paying higher rents on account of higher tenant improvement allowance effectively translates to tenant funding the improvements to the lab space. In the subsequent leasing cycles if the tenants leave, developers stands to gain from the value created by this allowance. Future tenants are incentivized to keep their tenant improvement allowance low and lease the space with the existing improvements. Thus developers create value by first, preserving the value of the existing asset and second, by preventing any further expenditure at their own expense on the asset. Lab building assets with market ready infrastructure are able to hold their intrinsic value because higher development cost of building a lab makes a speculative lab development highly risky. In addition, existing lab buildings with pre-existing infrastructure that is market ready is very attractive to potential tenants.

2.5 Development Process Considerations:

The high cost of construction of this building type makes the lab building development a strategically bifurcated process that operates in two phases. Base building development and leasing or tenant improvements are the two stages at which maximum value is created for the lab building types.

The development of base building involves understanding of the market and the users that will be using this building. This market and user research drives the programming of the buildings where during the design stages the proportion of the lab spaces, office spaces and infrastructure support systems are decided. To remain competitive in the market place, developers ensure that their buildings are designed for the level of infrastructure that is being offered in the market by their competitors. Sometimes base building is designed in such a way that it could function as a pure office building if the market for lab building deteriorates before the lab building infrastructure is put in. This allows developers to hedge their position in the asset during the base building development. Latest technological advances also allow developers to plan the utility infrastructure in a phased manner in the lab building. This allows developers to invest in only the utility infrastructure required by the tenant with an option to expand in the future if additional tenants require it. Generic infrastructure cost is borne by the developer but any specific requirements by the tenants that might not have value for the developer in the future are completed at the expense of the tenant. Partial build-out of the utility infrastructure also allows the developers to take advantage of advances in technology. As the technology improves for the various engineering systems, developers might be able to incorporate more energy efficient systems in the future that could reduce overall operating expenses and improve the tracking of energy use. Since the cost of development is high, development of lab buildings depends heavily upon the demand in the market, the ready availability of tenants for such a building and reduced speculative lab building.

After the development of the base building to office standards, developers create value for the lab buildings by ensuring that the tenants participate in scaling the infrastructure of building up to the wet lab standards. Developers also choose their tenants strategically. If the building was planned for the majority of the wet lab use, the developers tend to choose the wet lab tenant compared to dry lab or office use tenant so as to scale up the infrastructure in the building to a wet lab standard at the expense of the tenant. After the tenant leaves, the equipment installed in the building stays with the developer which is utilized to entice the next wet lab tenant and thereby preserves the value of the building. Already existing infrastructure in the building also helps reduce developer's tenant improvement (TI) allowance to the next tenant. After the cost of the infrastructure in the building is amortized, the developer gains flexibility to lease the space to a variety of tenants either office or dry lab.

Within this unique market dynamics of lab buildings, the developer creates value by first scaling the base building with its infrastructure to its fullest potential by strategically choosing the tenants and seeking their participation. Additional value is created as the infrastructure installed in the building is paid for by the tenant in the form of tenant improvement allowance. As the building goes through multiple leasing cycles, this tenant improvement allowance is reduced for every new tenant entering the building. In some cases, developer can also gain additional value in the form of tax benefits by depreciating some of the installed equipment to a lower timeframe than the overall building.

2.6 Development Costs

Development costs of lab buildings are higher than most other types of buildings, for several reasons:

- Varying Program space: the lab-to-office mix ratio (expensive space vs. inexpensive space) and higher floor-to-floor height requirements, mechanical space
- They require specialized rooms, specialized equipment, and casework.
- Lab buildings are usually constructed with a certain level of flexibility to accommodate different types of research in the future.
- Labs are energy intensive buildings as they have special mechanical equipment,

which consumes lot of power.

- The structural system must be designed for heavy loads and vibration control.
- There are usually several systems for piped gases, vacuum, and deionized water.
- Backup generators are usually required for critical functions like fume hoods, environmental rooms, vivarium facilities, and other special rooms and equipment.
- Lab Buildings have higher level of Safety features—such as eyewash and body wash at sinks, safety showers and safety cabinets.
- The building net-to-gross efficiency is usually low because of the amount of space necessary for mechanical, electrical, and plumbing equipment. Most labs require 100 percent outside air.
- Building requirements due to stringent fire code relating to hazardous uses
- 100% pass-through air circulation
- Extent of system redundancies

2014 new R&D facility construction costs by facility type[1]

Building type	2013 $/gsf	2014 $/gsf
Biomedical facility	436-456	449-469
Animal research facility	542-625	556-607
Toxicology facility	480-540	494-556
Chemistry research facility	480-530	494-546
Biology research facility	440-470	453-484
Analytical chemistry facility	366-406	377-418
Software development lab	322-354	331-364
Hardware development lab	386-426	397-439
GMP production facility Class 10,000	540-634	556-653
GMP production facility Class 1,000	704-810	725-834
GMP production facility Class 100	894-1,100	920-1,050
BSL-3	470-510	484-525
BSL-4	510-550	525-566
Greenhouse	327-394	337-406
K-12 biology/chemistry teaching lab	364-450	375-449
Advanced physical science research facility	520-725	535-746
Nanotechnology research facility	676-894	696-910

[1] Based on the research from HLW International LLP, Faithful+Gould for NY/Tri-State metro area.

The following percentages represent the typical lab construction budget allocations for each building work components:[2]

- Mechanical/ electrical/plumbing 30–50 % or more
- Casework 7–12 %
- Fixed equipment 5–10 % or more
- Structure 15–20 %
- General construction 20–25 %

In addition to these higher costs infrastructure systems in a lab building, the type of research conducted in the lab building also governs the development costs. The following are typical GSF construction costs of different kinds of lab and research facilities. GSF construction costs ranges from $320/GSF for software development lab to $1100/GSF for Good manufacturing practice (GMP) production facilities.

[2] Based on the research done by Architect Daniel Watch from Perkins + Will in his book 'Building Type Basics for Research Laboratories'

Following charts compare typical development costs of an office and a lab building.

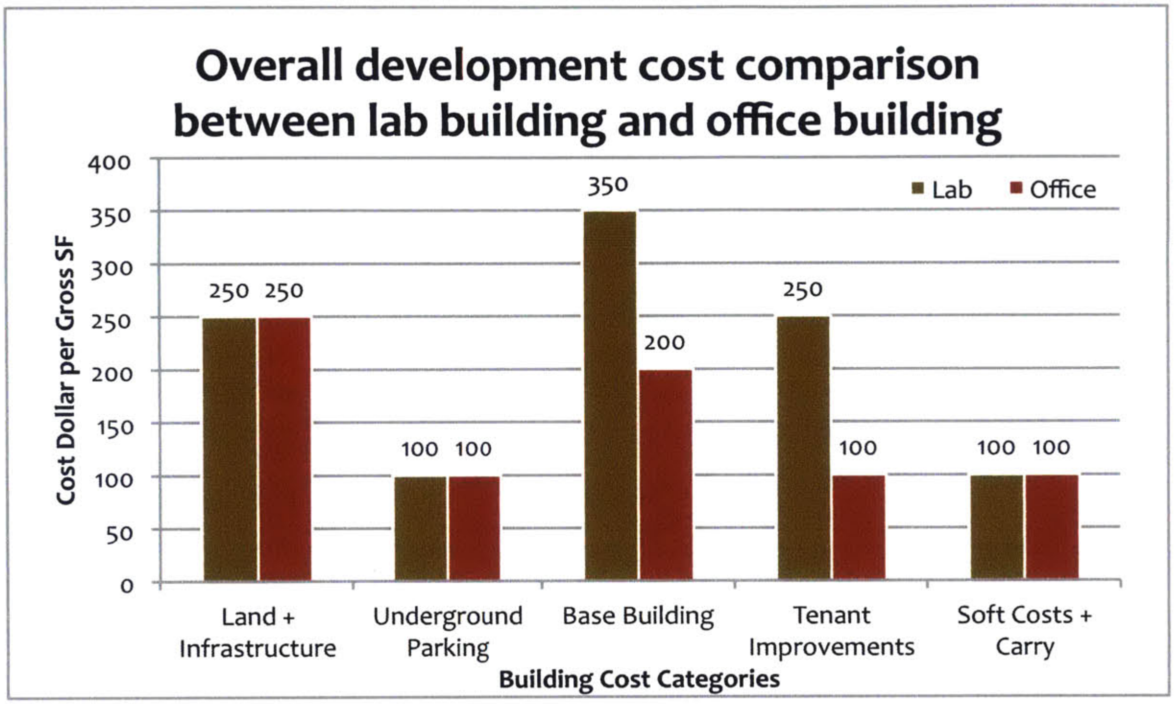

Figure 2-1 Development Cost Comparison between Lab Building and Office Building

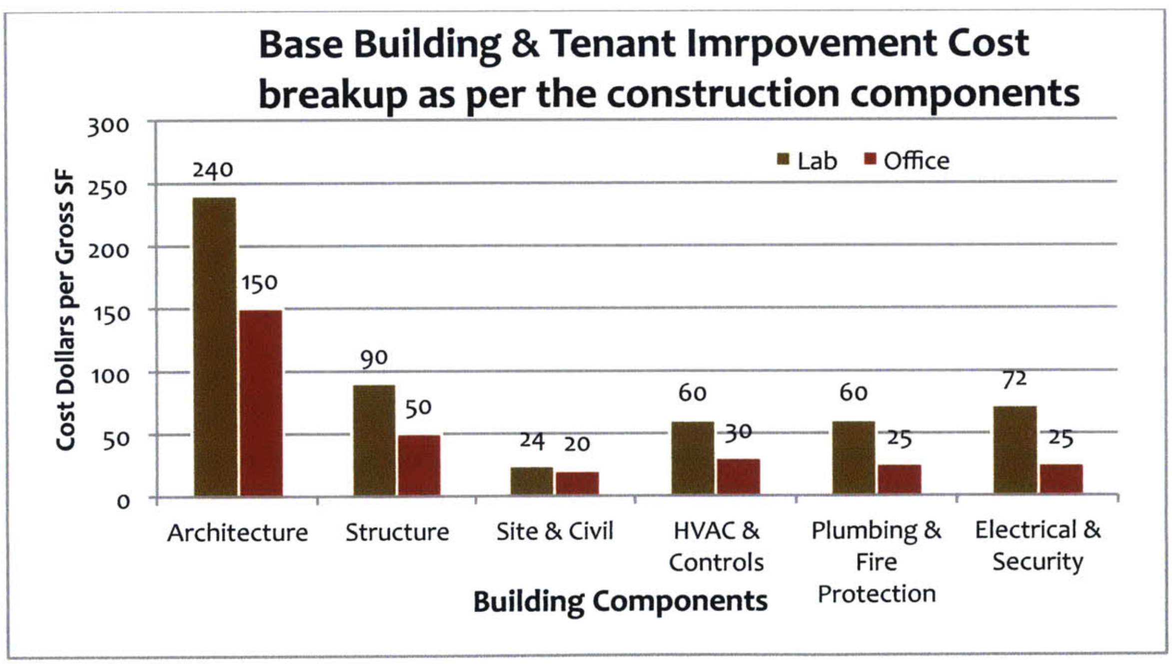

Figure 2-2 Base Building and Tenant Improvement Cost Break Up

The main difference between the development costs is visible in the Base Building costs and the Tenant Improvements offered by the developer for both the building types. Based on conducted interviews, the base building costs for a lab building are typical in the range of $350 – $225 per gross sq. ft. (GSF). Typical office building costs are $200 per GSF. A typical office-base building is an office building with unfinished interior that lacks heating, ventilation, air conditioning (HVAC), lighting, plumbing, and ceilings. The tenant adds these interior improvements with tenant improvement allowance offered by the developer. In the typical developer lab building the base building has the similar characteristic as the office build base building but the base building is designed with generic lab user in consideration. The lab base building may include higher floor heights, higher structural floor loads, vibration proof floors, pre planned space for mechanical equipment for very specific HVAC equipment, modular floor shafts to accommodate various piping requirements of the lab and higher fire safety construction standards. All these factors contribute to higher base building costs for the lab building.

Tenant improvement costs in lab buildings are on an average higher than the tenant improvements costs for office buildings because all the specific ventilation and utility requirements in the tenant floor space. The combination of higher base building and tenant improvement costs in the lab building are broken up in different construction components as shown in the chart 2. On an average the lab building engineering costs are around 40 percent of the over all lab building construction costs.

3 Flexibility in Lab Buildings

Higher capital costs and constantly changing research environments require lab buildings to be as flexible as possible. Flexibility in lab buildings is incorporated at several levels, from the ability to expand the building horizontally or vertically to readily accommodating multiple lab user types.

3.1 Flexibility to expand:

In general, lab building can be designed for future expansion. To incorporate flexibility to expand, the site infrastructure and utilities need to be planned with the final capacity in mind. Horizontal expansion can be achieved by building a separate lab building on site. Flexibility to expand vertically on a land-constrained site requires extensive co-ordination and planning of all the building systems including structural and mechanical systems[3]. It is also essential to design mechanical and HVAC systems in such a way that the existing lab building can be fully operational during the construction period. As lab buildings require controlled environments in the lab spaces, the expansion-vertical or horizontal, is easier to implement for institutional or owner occupied lab buildings rather then a developer driven multi-tenant buildings. Expansion might involve the reconfiguration of the existing mechanical and HVAC systems which might be difficult to implement in a multi tenant developer driven lab building due to potential disruption to the existing lab operations and potential legal ramifications. If lab users have been brought onboard with the expansion process and the construction is staged such that the impact on the existing process is minimal and manageable, an expansion process is achievable in an institutional or owner occupied lab building or single tenant lab building.

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[3] Texas Children's Hospital, Feigin Center (an institutional lab building) vertical expansion project added eight floors and more than 200,000 sft of space to an existing 12-floor research building and required extensive coordination among existing building users during construction.

3.2 Flexibility to accommodate change:

Lab buildings require flexibility as they serve diverse users involved in variety of different sciences. To incorporate this flexibility the lab building floor plans are designed on a basic laboratory module of 10'6" width and depth of 20'-33' range. This lab module is important because typical lab bench furniture, equipment and utilities are designed to fit into this module in addition to circulation space required for research work. When designed correctly a lab module will fully coordinate the architectural and engineering systems.

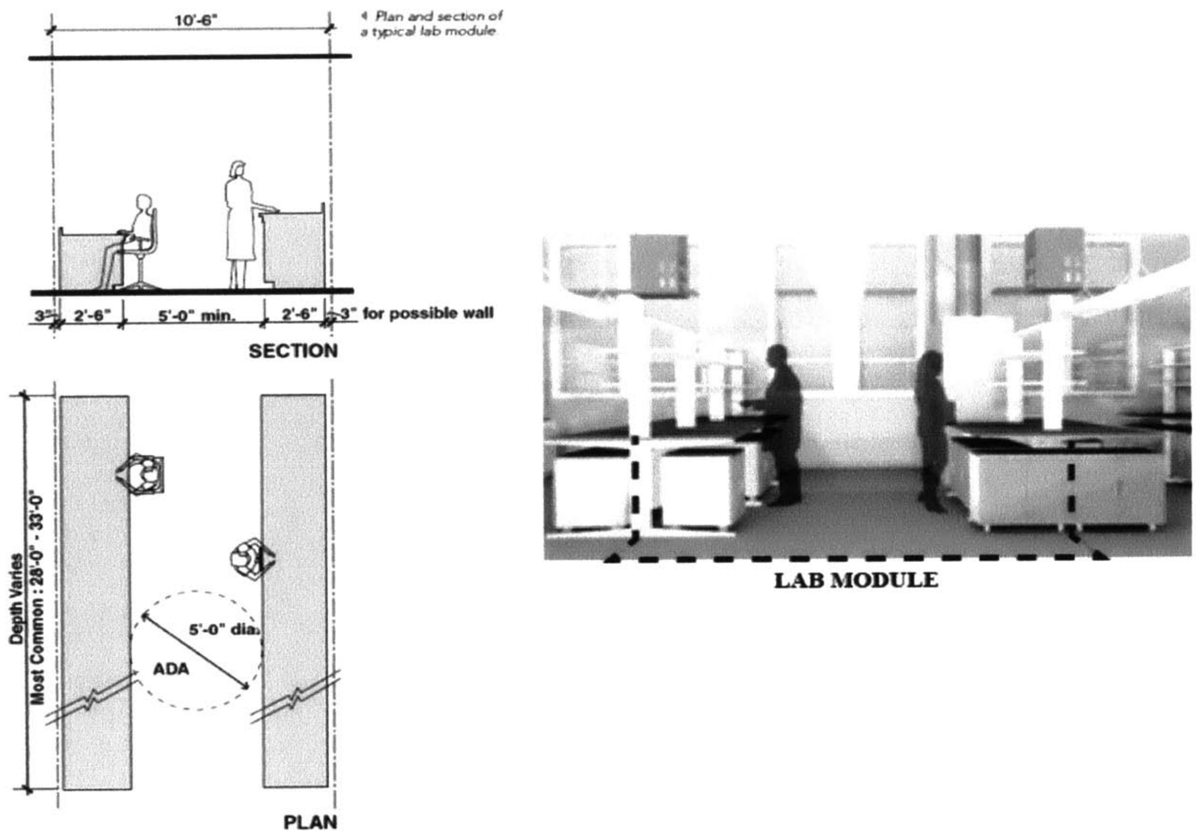

Figure 3-1 Typical Lab Module in Lab Buildings
Watch, Daniel. Plan and section of a typical lab module. 2001. Building Type Basics for Research Laboratories.

Based on this lab module, the different types of laboratory spaces such as labs, lab support spaces and offices are expressed as multiples of this module. The lab designed on these standards allows multiple configurations of a floor plan from clinical space for medical institutions to lab and office space for life science companies within the same building. So the developer is able to accommodate a variety of tenants with different space requirements and configurations within a building. As the building is designed with lab use in mind and with capital-intensive infrastructure, the tenant involved in lab based research offers the highest rental income to the developer; much more than a typical office space user in a lab building. Here the developer is more inclined to seek out lab tenants to create economic value for their capital invested. In addition to this lab module based building design, the base building is designed with higher floor to ceiling heights and vibration proof floor slabs to accommodate a variety of sensitive equipment used in the life sciences research.

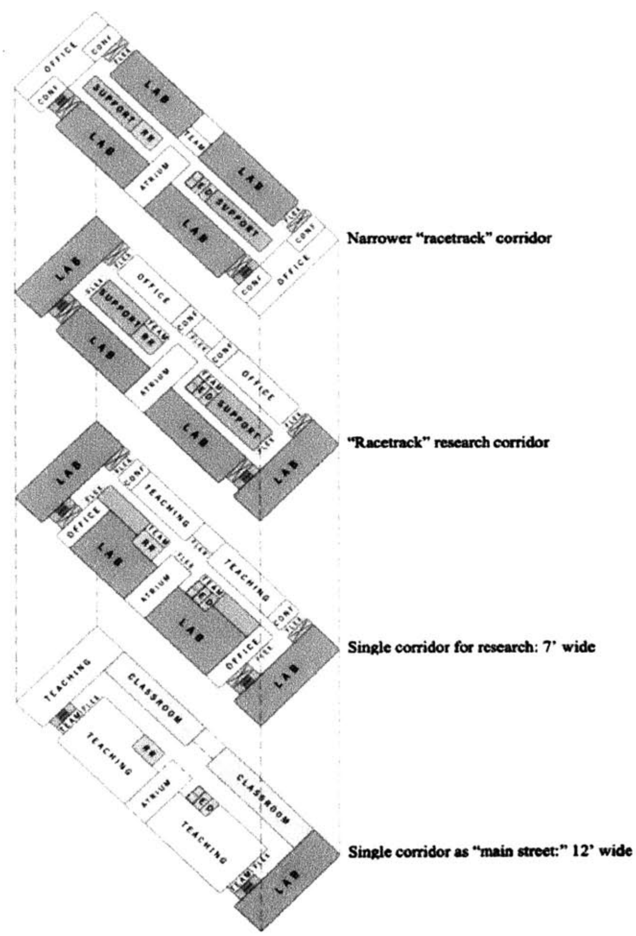

Figure 3-2 Different Layout Options for Lab Building Floor.
Watch, Daniel. Three Dimensional Lab Module. 2008. Building Type Basics for Research Laboratories.

The floor plans illustrate that multiple corridor arrangements can be provided on different floors to support a variety of programs and allow the building to be even more flexible.

Figure 3-3 Longwood Center in Boston.
Alexandria Real Estate Equities, Inc. et al., Marketing Plans, 2015.
http://www.longwoodcenter.com/pdf/clinical_test_fit.pdf

The building floor plan is designed to accommodate clinical use for potential hospital tenant or lab use for potential research tenant. Lab floor plan option depicts three different zones of lab, office and lab support areas.

3.3 Flexible engineering systems

In addition to flexible building and floor plans, the lab building also requires flexible engineering systems to fulfill the needs of the different user types. Engineering services—supply and exhaust air, water, electricity, voice/data, vacuum systems—are critical to maintain the controlled environment required for research. To serve diverse lab uses, tenant space must have easy connects/disconnects in the tenant space to allow for fast, affordable hookups of equipment. The engineering systems capacity may need to be designed to the maximum capacity by planning for all eventualities or by applying an engineering diversity factor.[4] Engineering Diversity Factor allows for flexibility in location of systems and convenience while reducing investment in head end systems. Engineering systems need to enable the addition/removal of additional fume hoods and equipment. System design should allow the space to be changed from a lab environment to an office and then back again.

From the start, building should be designed with vertical risers and shafts at regular intervals to allow for addition and removal of supply and exhaust air, fume hoods, clean and treated water and various gases as the tenant may require. Overall mechanical systems including, heating, plumbing, air conditioning chillers, air handling units and building exhaust systems need to handle the maximum load required by the tenants. These overall systems need to be capable of re-balancing the air quality to the required level and exhaust special chemicals and toxic gases from each of the tenant's lab spaces on a daily basis. The waste and clean

[4] As per Architect Erik Karl Lustgarten, Gensler, one consideration in designing the engineering systems is whether to design for maximum capacity versus applying an engineering diversity factor. For example, the system may have connections in the ceiling on one floor for 30 fume hoods, but the systems are sized under the assumption that only 25 of them might be used at one time. Another example would be where 2 actual vacuum turrets are provided at each bench for convenience, but the design assumes that only 85% of the turrets will be in use at one time. A diversity factor can allow for flexibility in location of systems and convenience while reducing investment in head end systems, but the factor must be clearly communicated and known to building operators and tenants.

water systems need to be designed to treat the chemicals from the drained water before it is released in the public drains and provide highest purity water for lab use. All these factors require a complex and critical engineering system designed at a building and individual space level. Vertical risers, shafts and potential future connections in the tenant space and overall system capable of handling the complexity of a lab environment, incorporated in the lab building during the initial construction offers flexibility to the developer to attract lab user tenant.

4 Real Option Analysis of Lab Building

This chapter presents a real options "engineering –based' model for a typical lab building development. It should be noted that the numbers and detailed specifications of the model developed in this thesis do not correspond directly to any actual real world commercial lab building project. This is done both to protect proprietary information and to simplify the analysis to facilitate its illustrative value. While the specifics differ slightly from the actual reality, the model well represents the essential characteristics of the lab building project, as it is relevant for the present research.

The following steps define the methodology for the Real Options Analysis for the lab building. With this methodology, various scenarios will be developed as described under different steps:

1. Define assumptions for the overall model.
2. Develop initial deterministic Direct Cash Flow (DCF) Proformas
   - ***I. Scenario 1 - Full Build Out (Inflexible) Scenario***

     Base case lab building scenario without any flexibility
   - ***II. Scenario 2 - Full Build Out – Office Scenario***

     An alternative office building scenario without any flexibility to validate the lab building use as a highest best use (HBU) for the site
   - ***III. Scenario 3 - Flexible Build Out Scenario***

     Flexible lab building DCF Model
3. Identify uncertainty variables, incorporate them in the proforma of scenarios i) through iii) and analyze possible future outcomes with Monte Carlo Simulation.
4. Determine the criteria for decision-making structure to develop the flexible lab

building model with an ability to switch use to an office use to mitigate uncertainty.

IV. ***Scenario 4 - Flexible Build Out with Office Switching Option***

5. Interpretation of the results using value at risk or gain (VARG) curves.
6. Analyze sensitivity of the valuation to uncertainty variables.

4.1 Step 1: Data and Assumptions

Following assumptions have been utilized to develop this model:

Table 4-1 Valuation Analysis Assumptions:

Valuation Analysis & Assumptions					Notes & Comments
Schedule					
Land Acquisition/Closing Financing Start	Year 0				
Design & planning (Soft Costs)	Year 1				Hypothetical Schedule assumes 12 month for design and planning
Construction (Hard Costs)	Year 2 - 3				Schedule assumes 2 year construction period
Leasing Period	Year 4				Schedule assumes that the developer will start marketing the building mid construction and the building will be preleased to accommodate tenants at the start of year 4
Sale Period	Year 24				Leases in the lab spaces are of 7 to 10 year duration, building will go through two - 10 year leasing cycles in year 4 and 14 and will be sold at the end of year 24
Building Program					
Total RSF	150,000				Assumed Building size for simplicity
GSF/RSF Ratio	1.10				
GSF	165,000				
Development Costs	**Typical Lab**		**Typical Office**		
Total Cost/GSF					
Land + Infrastructure	24%	$250	33%	$250	Based on 2015 average construction costs collected during research interviews
Underground Parking	10%	$100	13%	$100	
Architecture Core & Shell	33%	$350	27%	$200	
Tenant Improvements	24%	$250	13%	$100	
Soft Costs + Carry	10%	$100	13%	$100	
Total Cost/GSF	**100%**	**$1,050**	**100%**	**$750**	
Rent					
Rent ($/SF) Per Year	$65		$55		Current market rents as per CBRE's New England Market Outlook - 2015 for typical lab building and office building in Cambridge MA and Boston MA submarket respectively
Rent Growth/Year	1.25%				Based on average real growth in rents from 1980-2015
Inflation	2.90%				Based on average inflation from 1982-2015
Vacancy	8.00%		6.90%		Assumed as per CBRE's New England Market Outlook - 2015
Expenses					
Operating Expenses $/SF	$11.77		$11.77		Assumed at $11.77/GSF as per the BOMA Standards. Lab Tenants to have NNN Leases
Tenant Improvements	$250		$60		Assumed as per the data received
Leasing Commissions	1%		1%		Assumed as % of NOI For simplicity
Capital Ex Reserve	15%		15%		Assumed as % of NOI for Simplicity
Finances					
Exit Cap Rate	5.67%				
OCC	5.65%				2.9% Tbill Rate + 2.75% RP on Stabilized Asset

Assumptions about various scenarios developed under different steps are described below:

4.1.1 Full Build Out (Inflexible) :

This scenario assumes that the lab building will be built without any kind of flexibility. Base building will be built out completely with a deterministic assumptions as per prevailing market conditions without any flexibility to scale up the base building as per future tenant requirements thus no cost savings are gained in the base building costs as the entire base building budget is expended. This scenario also assumes that base building does not include any kind of flexibility to expand, accommodate change or flexible engineering systems as described in the chapter 3. Further this scenario assumes that there is no flexibility to build up the tenant space for generic lab user and full tenant improvement allowance of $250/sf will be offered to the tenants during each 10 year leasing cycle.

4.1.2 Full Build Out – Office (Inflexible):

This scenario is developed for comparison purposes to understand, whether the highest and best use of the site is an office or a lab use. This scenario assumes that an office building will be built based on deterministic assumption without any kind of flexibility. Construction cost ($710/gsf) and tenant improvements costs ($60/sf) will be based on a typical office building construction. Leasing cycles are assumed to be of 5 year.

4.1.3 Flex Build Out (Flexible):

This scenario assumes that the lab building will be built with flexibility to scale up the base building as per the tenant requirements. With this assumption, the 20% base building cost is spread out in year 4 and year 5 after the tenants have moved in. This scenario also assumes that base building includes flexibility to expand, accommodate change and flexible-engineering systems as described in the chapter 3. In addition, this scenario assumes that the tenant improvements allowance offered would be utilized towards generic improvements, which could be utilized by future tenants. With this assumption, the model assumes that year 14 and year 24 tenant improvement allowances will be 66% and 33% of the original tenant allowance of $250/sf excluding any adjustments due to inflation.

4.1.4 Flex Build Out with Office Switching Option:

This scenario is similar to the Flex Build Out (Flexible) scenario but in addition to being a flexible building, this scenario assumes that the developer will be able to switch the building use to an office use if the lab space market is experiencing negative growth in comparison to an office space market. The simulation of this model has a switching option to office use at office rents ($55/sf) and office tenant improvement allowance ($60/sf) during year 4, year 14 and year 24, if the lab market experiences negative average growth of 5% or more in preceding two years and office market is experiencing positive growth. This scenario allows for switching during any or all of the leasing cycles to office use if the lab market experiences the negative growth as per the trigger value. 2000 random Monte Carlo simulations generate the lab and office space growth trigger values.

- The model assumes that the lab building will go through reversion at the end of the year 24.
- The land price and site improvements are $250/sf. The model also assumes that this will be a zero NPV project and any positive NPV is added towards the purchase price of the land.

4.2 Step – 2: Develop Initial Deterministic Cash Flow Proformas

In order to be able to value flexibility in lab buildings, it is essential to establish deterministic base case. For this model the Scenario 1 - Full Build Out (Inflexible) case is the deterministic case, as it includes no flexibility. This base case DCF analysis results in the following NPV and IRR at 5.65% OCC

Scenario 1 Full Build Out – (Inflexible)

NPV at 5.65% OCC: -$40.55 m

Overall Project IRR: 4.38%

Though the project shows negative NPV, overall IRR shows 4.8%. Also we are mainly concerned about the difference in NPV between the base case scenario and the flexible case scenario to understand the value of flexibility. We also establish a NPV for the Scenario 2 - Full Build Out – Office and NPV for the Scenario 3 - Flexible Build Out with deterministic assumptions to understand the highest and best use for the site. They are as shown below:

Scenario 2 Full Build Out - Office

NPV at 5.65% OCC: $9.19 m

Overall Project IRR: 7.3%

Scenario 3 Flexible Build Out

NPV at 5.65% OCC: $4.66 m

Overall Project IRR: 6.86%

Comparing the three deterministic scenarios, it is evident that Scenario 2 and 3 have higher and positive NPV and IRR than Scenario 1. Further, Scenario 2 and 3 have a similar NPVs, which implies that the new building can either be an office use or a lab use. This also implies that the developer with office development or flexible lab development incorporating various flexibilities as described in Chapter 3 will be able to bid higher for the land than the developer who will be developing non-flexible building as in Scenario 1. Higher NPV of Full Build Out – Office Scenario shows that the site should be developed as an office. Further analysis of this Full Build Out – Office Scenario under uncertainty might prove or disapprove this conclusion.

4.3 Step 3 - Identify uncertainty factors and incorporate into cash flow

After the deterministic NPV is established, uncertainty will now be injected in both the scenarios to create stochastic models. In the real estate industry, the most critical factor that drives the decision-making is the return of the projects, which is the present value of revenues minus present value of cost. Of these two factors, the value of the underlying asset is more volatile than the cost. There can be several uncertain variables that can make the underlying asset more volatile. In order to best represent the market uncertainty, the uncertain variables for this model will be projected rent for the lab space and the office space.

Deterministic model uses $65/SF rent for the lab space and $55/sf rent for the office space. These rents are based on current (2015 – Time 0) market rents for the lab and office space in the Boston Metro area. However we do not know where the economy will be in next 4 years, when the asset comes on the market. To represent this uncertainty, we can allow the rents to be affected by several variables like volatility, market noise, idiosyncratic volatility and noise, long term- market trend, and differential trend between different asset classes and the construction costs.

We assume following uncertainty variables for the models:

Assumed uncertainty & dynamics inputs			Notes
Init Rent/SF Half Range		$0.02	Assumed Initial rent per sf per year half range to be applied to random realization factor of initia rent
Trend/yr Half Range		1.00%	50% range for the overall market trend
Trend/yr Mean		-1.00%	Asset Value long term secular market trend is set to be -1% to simulate a negative trending market
Volatility/yr		10.00%	Short Run Asset market volatility of 10 % was calculated based on the the last 10 years rental data from brokers.
AR parameter		0.2	
RentCycle Amplitude		35%	15 year cap rate cycle based on Moody's/REAL, TBI avergae cap rate cycle of 10-20 years with amplitude 20-40%
Caprate Mean		8.00%	Assumed cap rate mean
CaprateCycle Amp.		2.00%	Assumed cap rate cycle amplitude of 200bps
RentCycle Phase		2.5	Rent cycle phase at the which the property enters the market
Caprate Cycle Phase		3.8	Caprate cycle phase at which the property enters the market
Rent Cycle Perod		10	Assumed rent cycle in years around overall market trend
Caprate Cycle Period		15	15 year cap rate cycle based on Moody's/REAL, TBI avergae cap rate cycle of 10-20 years with amplitude 20-40%
Noise (half range)		0.00%	Random deal noise around true value. Does not accumulate over time.
Black Swan Prob		5%	5% probability for a calamitious event which can affect the market
Black Swan Effect		-25%	Magnitude of ffect of Black Swan event on the over all trend
LAB Space	Differential Trend	1.00%	Lab space market trend is assumed +1% differential from the market trend
	RE Idio Volatility	5.00%	This volatility inherent in the lab space market is assumed to be 5% beyond the volatility in the market
	Betas	1	Systemic risk wrt to the market is assumed to be 1. The asset is highly correlated with market all other things being equal
	RE Idio Noise	5.00%	Random deal noise around true value. Does not accumulate over time.
Office Space	Differential Trend	0.00%	office space market trend is assumed to be inline with the market trend
	Idiosync Volatility	5.00%	This volatility inherent in the office space market is assumed to be 5% beyond the volatility in the market
	Beta wrt Mkt	1	Systemic risk wrt to the market is assumed to be 1. The asset is highly correlated with market all other things being equal
	Idiosync Noise	5.00%	Random deal noise around true value. Does not accumulate over time.

Figure 4-0-1 Assumed Uncertainty Variables for Models

Based on the aforementioned asset and space market variables, Monte Carlo simulation will randomly create 2000 iterations of the model with its different NPV and project IRR. The NPV results are then averaged and summarized in the graphic form through histogram and VARG chart.

4.3.1 Scenario 1 - Full Build Out (Inflexible) with Market Uncertainty

The valuation of the Full Build Out (Inflexible) Scenario with market uncertainty is built up on the deterministic DCF model but replaces the starting rent in 2019 from $65/sf to rents based on uncertainty. Monte Carlo simulation computes 2000 iterations of the NPV based on the Random Realization Factors generated rent values. Random Realization Factors are generated based on the uncertainty variables defined for the model. The following tables summarize the simulation result for the NPV.

Output:
Simulation Results NPV Statistics
Full Build Out (Inflexible) Scenario:

Mean (ENPV)	**23.33 m**
Maximum	**947.25 m**
Minimum	**(159.73 m)**
Standard Deviation	**127.07 m**

The ENPV of this Full Build Out (Inflexible) Scenario is approx. $23M, which is substantially higher than the negative NPV from the deterministic model as described in section 4.2. The worst-case scenario shows the NPV of approximately - $159.0 M and the best scenario shows the NPV of $947.0 M.

Monte Carlo simulation will not always compute the exact same ENPV as it is an average NPV of 2000 random simulations. If the numbers of simulations are increased, there is less fluctuation in ENPV and true range of results can be achieved.

Figure 4-0-2 is a Value at Risk and Gain (VARG) Curve that shows the probability of reaching the certain NPV. According to the VARG chart, there is approximately 55% probability that the project will have a negative NPV.

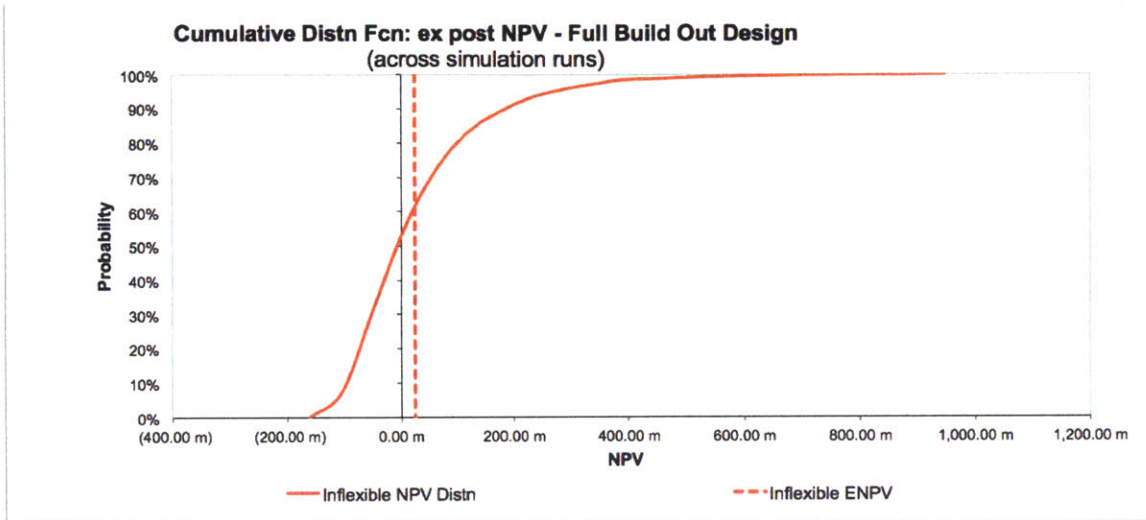

Figure 4-0-2 VARG Graph for Full Build Out – Inflexible Case

Figure 4-0-3 is a histogram that graphically compiles and displays all possible NPVs proportionally to their value. Positively skewed histogram shows almost 55% of the resultant NPVs within a range of -\$159.0M to \$0.10M.

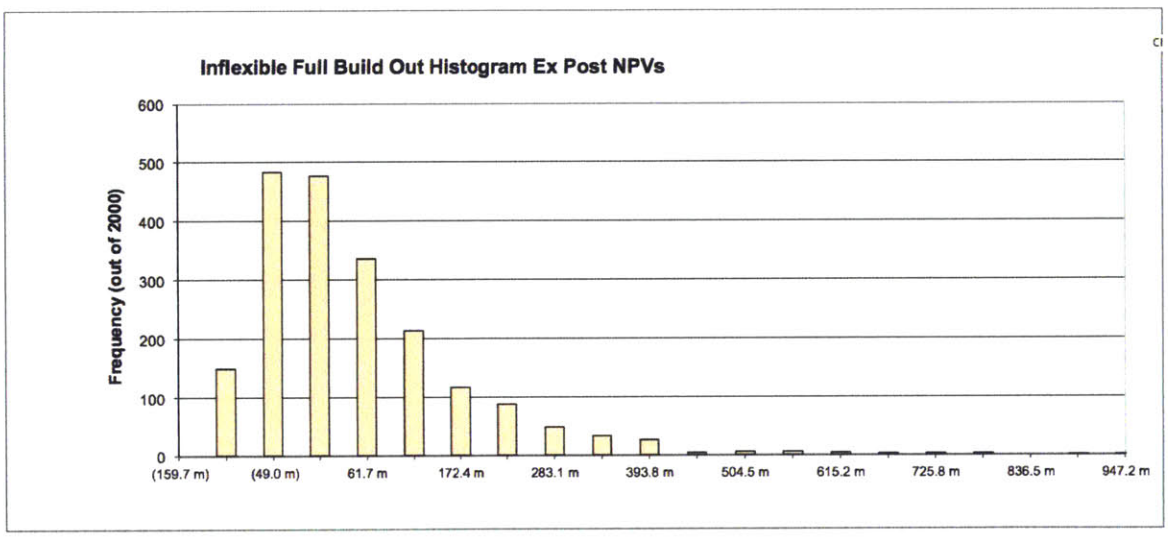

Figure 4-0-3 Histogram for Full Build Out – Inflexible Case

4.3.2 Scenario 2 Full Build Out – Office Scenario with Market Uncertainty

We also develop the valuation of the Full Build Out – Office Scenario under market uncertainty. Similar to the previous section, Monte Carlo simulation computes 2000 iterations of the NPV based on the Random Realization Factors generated rent values. The following tables summarize the simulation result for the NPV of the Full Build Out – Office Scenario

Output:
Simulation Results NPV Statistics
Full Build Out- Office Scenario

Mean (ENPV)	**26.27 m**
Maximum	**422.23 m**
Minimum	**(76.95 m)**
Standard Deviation	**64.15 m**

Compared to the Scenario 1 as developed in the previous section, the office scenario has a similar Expected NPV (ENPV) of $26.2 M but has a lower downside risk and lower upside profit potential compared to the deterministic lab scenario 1.

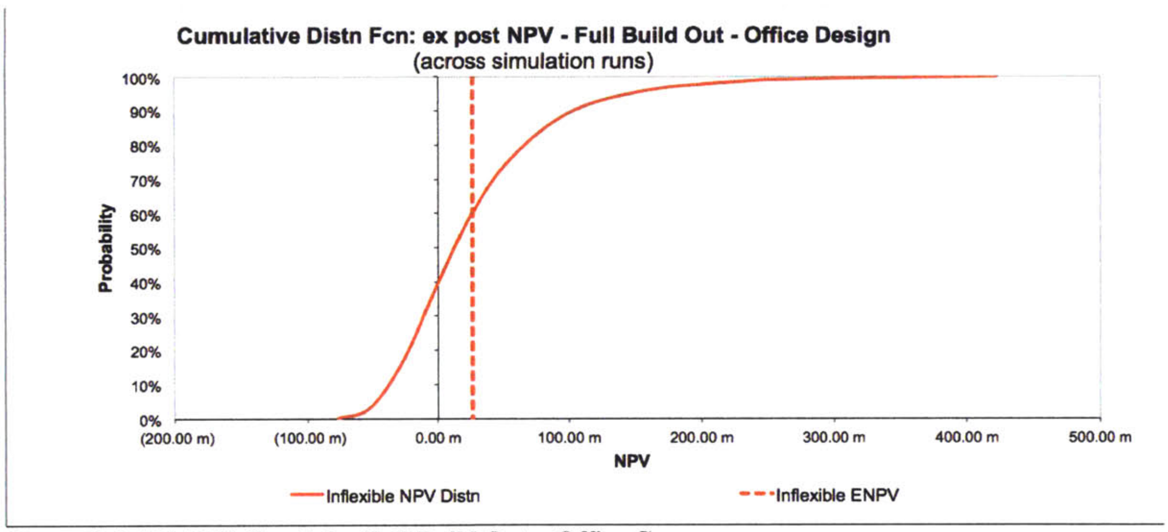

Figure 4-0-4 VARG Graph for Full Build Out – Office Case

Figure 4-0-4 is a Value at Risk and Gain (VARG) Curve for the office scenario and shows approximately 40% probability that the project will have a negative NPV. This 40% probability for negative NPV is less than the 55% negative NPV probability of Full Build Out scenario.

Figure 4-0-5 is a histogram that graphically compiles and displays all possible NPVs for the office build out case.

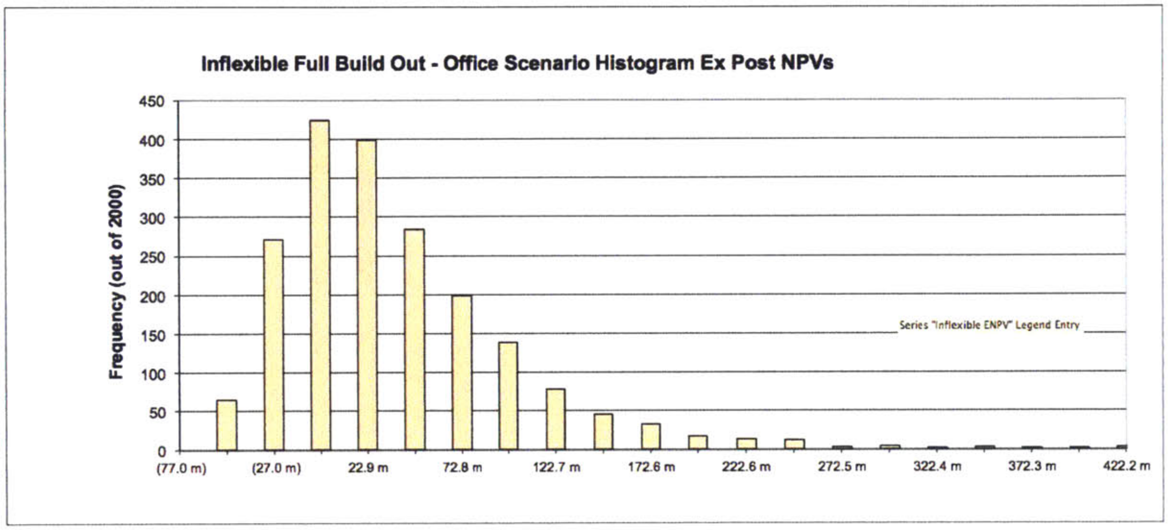

Figure 4-0-5 Histogram for Full Build Out – Office Case

4.3.3 Scenario 3 Flexible Build Out with Market Uncertainty

To compare the valuation of the flexible building with inflexible lab and office building, we develop a Flexible Build Out Scenario under market uncertainty. We develop this scenario based on the deterministic DCF model and include similar uncertainties as we did in our previous models. The following tables summarize the simulation result for the NPV of the flex build out scenario.

Output:
Simulation Results NPV Statistics
Flexible Build Out Scenario with Market Uncertainty:

Mean (ENPV)	**51.85 m**
Maximum	**809.39 m**
Minimum	**(125.95 m)**
Standard Deviation	**110.18 m**

The ENPV of this flex build out scenario is approx. $51.8M, which is substantially higher than the deterministic models as described in section 4.3.1 & 4.3.2. The worst-case scenario shows the NPV of approximately -$125.0 M that represents a lower downside NPV than Full Build Out Scenario. The best scenario shows the NPV of $809 M that is lower than the Full Build Out Scenario.

Figure 4-0-6 is a Value at Risk and Gain (VARG) Curve that shows the probability of reaching the certain NPV. According to the VARG chart, there is less than 40% probability that the project will have a negative NPV. This 40% probability for negative NPV is less than the 55% negative NPV probability of Full Build Out scenario and very similar to 40% probability of negative NPV of Full Build Out – Office scenario.

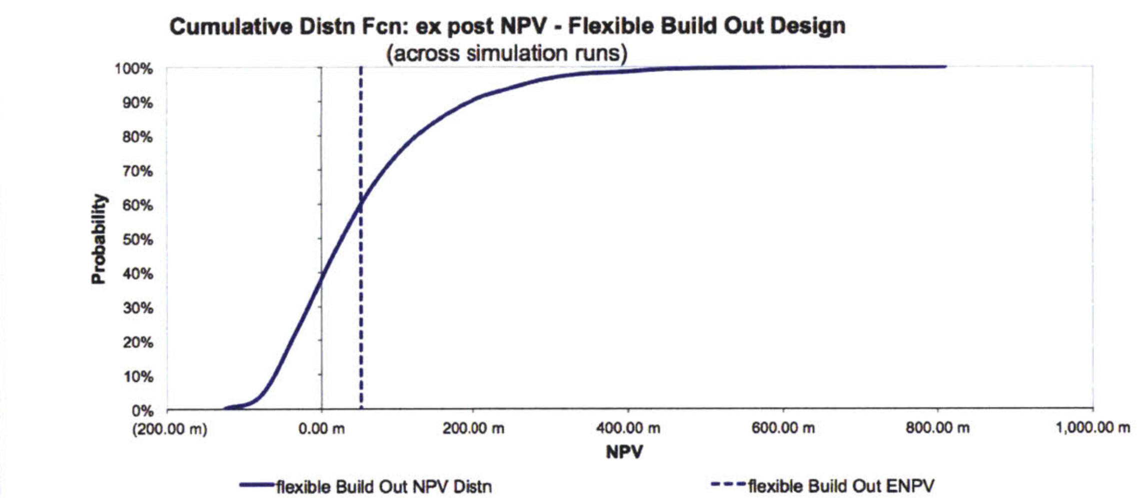

Figure 4-0-6 VARG Graph for Flex Build Out – flexible Case

Figure 4-0-7 is a positively skewed histogram that shows almost 40% of the resultant NPVs within a range of -$126.0M to $0.0M.

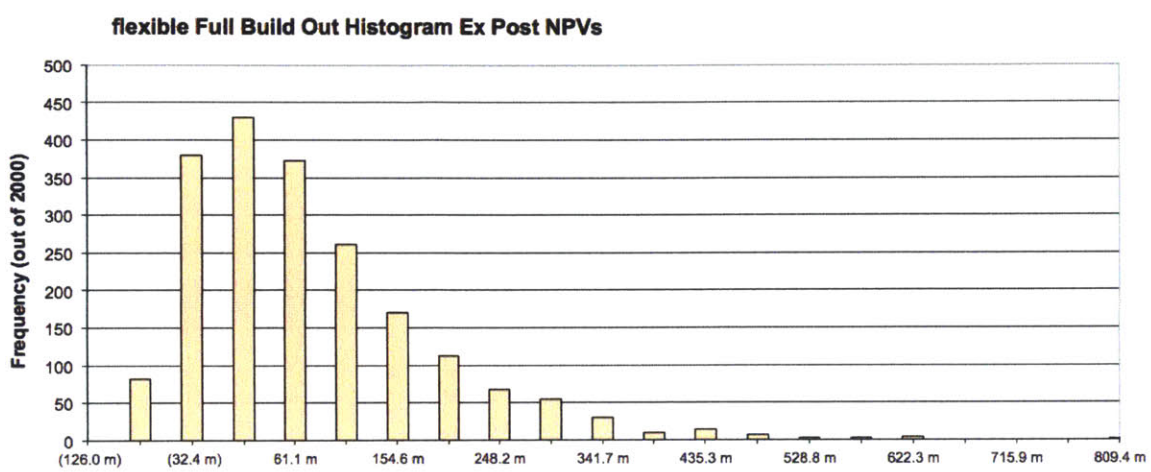

Figure 4-0-7 Histogram for Flex Build Out – flexible Case

Following Figure 4-0-8 shows a VARG graph where all the three cases are displayed.

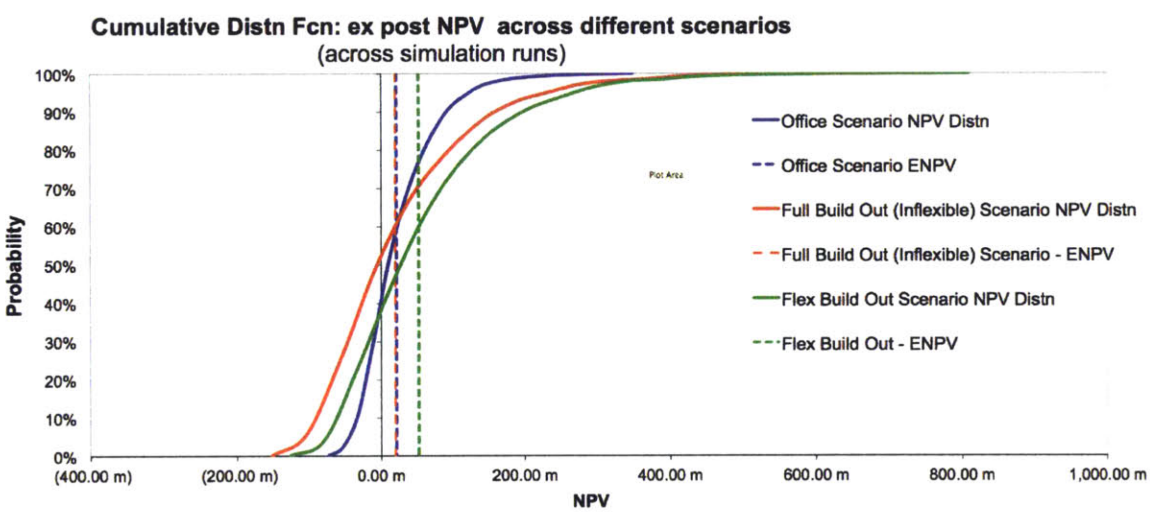

Figure 4-0-8 Comparative VARG Graph across different scenarios

4.4 Step – 4 Determine Criteria for Decision Rules and implement Flexibility to switch building use to Office Use

After developing different scenarios with uncertainty, we can further implement flexibility in the model by employing decision rules. If these decision rules are triggered based on certain market conditions, then the building has the flexibility to switch to the office use.

A lab building designed with various flexibilities as described in Chapter 3 should be able to accommodate an office use if the lab space market is going through a downturn. Based on this criterion, the following decision rule is implemented in the model.

IF in Year **4,14 or 24** Lab market is less than Trigger Value AND Office Market Greater than Lab Market THAN Rent the space as Office Space at Office Rents and Office TI, OTHERWISE Rent as Lab Space at Lab rental rate.

For the above decision rule, we set negative growth of 5% in the lab market as a value that will trigger the decision to rent the space to the office tenants at office rental rates and office tenant improvements. For this model the office rental rates are considered $55/sf and tenant allowance of $60/sf is considered.

The Flex Build Out model with uncertainty incorporates above decision triggers and its ENPV is generated by running Monte Carlo simulations. The results of the simulations are as shown below:

Output:
Simulation Results NPV Statistics:
Flexible Build Out with Office Switching Option

Mean (ENPV)	**45.11 m**
Maximum	**939.84 m**
Minimum	**(120.63 m)**
Standard Deviation	**112.55 m**

It should be noted that while running simulations the decision rules to rent as office space triggered in very few instances. The decision to rent the space as office space in both the leasing cycles in year 4 and year 14 triggered even less frequently. The ENPV of this scenario is approx. $45.1 M, which is very close to the Flex build out model. The worst case scenario shows the NPV of approximately -$120.6 M and best case scenario shows the NPV of $939.8 M, both of which are very close to the Flex Build Out scenario.

According to the Fig 4-0-9 VARG chart, there is approximately 40% probability that the project will have a negative NPV, very similar to Flex Build Out scenario.

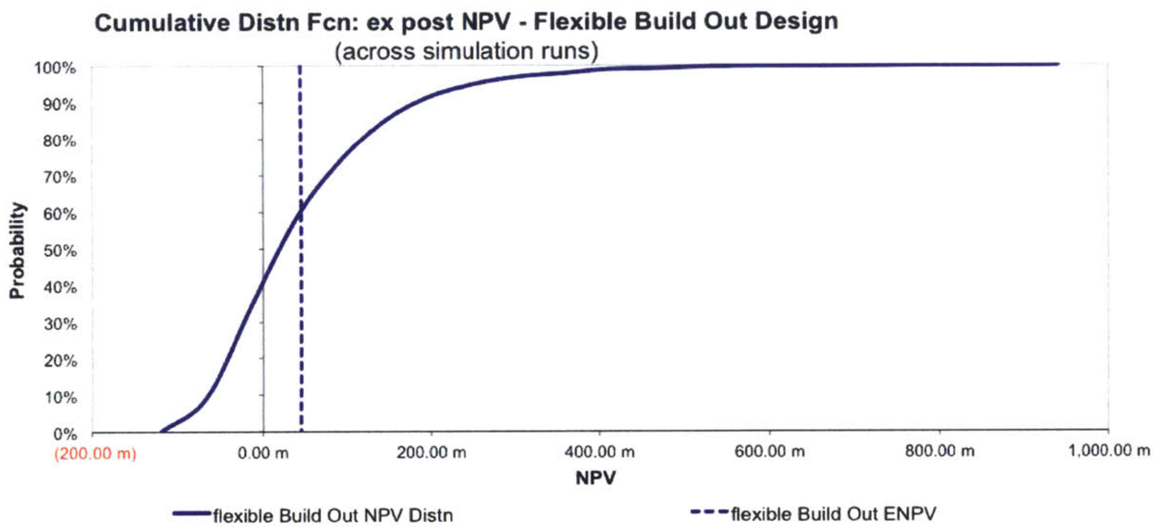

Figure 4-0-9 VARG Graph for Flex Build Out – with Office Switch Option

Figure 4-0-10 is a positively skewed histogram that shows almost 40% of the resultant NPVs within a range of -$120.6 M to $0. 0M.

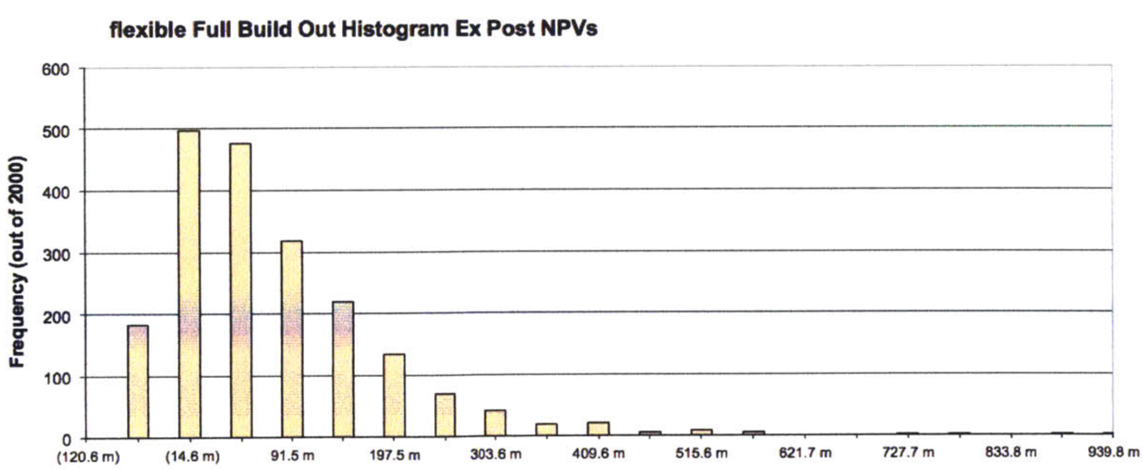

Figure 4-0-10 Histogram for Flex Build Out –with Office Switch Option

4.5 Step 5 – Sensitivity Analysis

4.5.1 Volatility:

In order to observe the relationship between volatility and Expected NPV, sensitivity analysis is developed. Observations are developed for +1% and -1% value of lab space differential trend to simulate the positively and negatively trending lab space market. Following figures depict the effect of different volatilities on expected NPV. As the volatility increases the ENPV value increases. Flexible Build Out with Office Switching Option has the highest ENPV, as the volatility increases the option to rent space as an office space gains value.

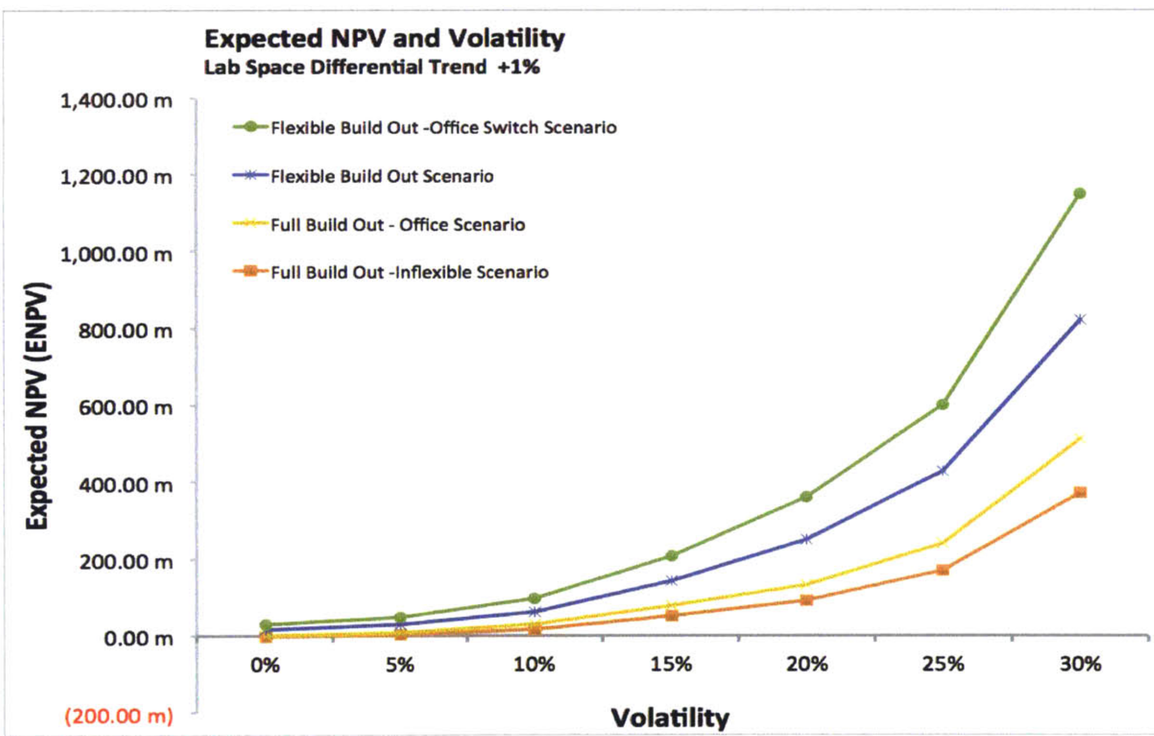

Figure 4-0-11 Sensitivity of ENPV on Market Volatility with Lab Space Differential Trend of +1%

With a lab space differential trend of -1%, negative ENPV is observed at low volatility and this ENPV rises as the volatility increases. Again Flexible Build Out with Office Switching Option has the highest ENPV at high volatilities. Full Build Out (Inflexible) Scenario without any kind of flexibility is affected adversely by low volatilities and only shows positive ENPV at high volatilities.

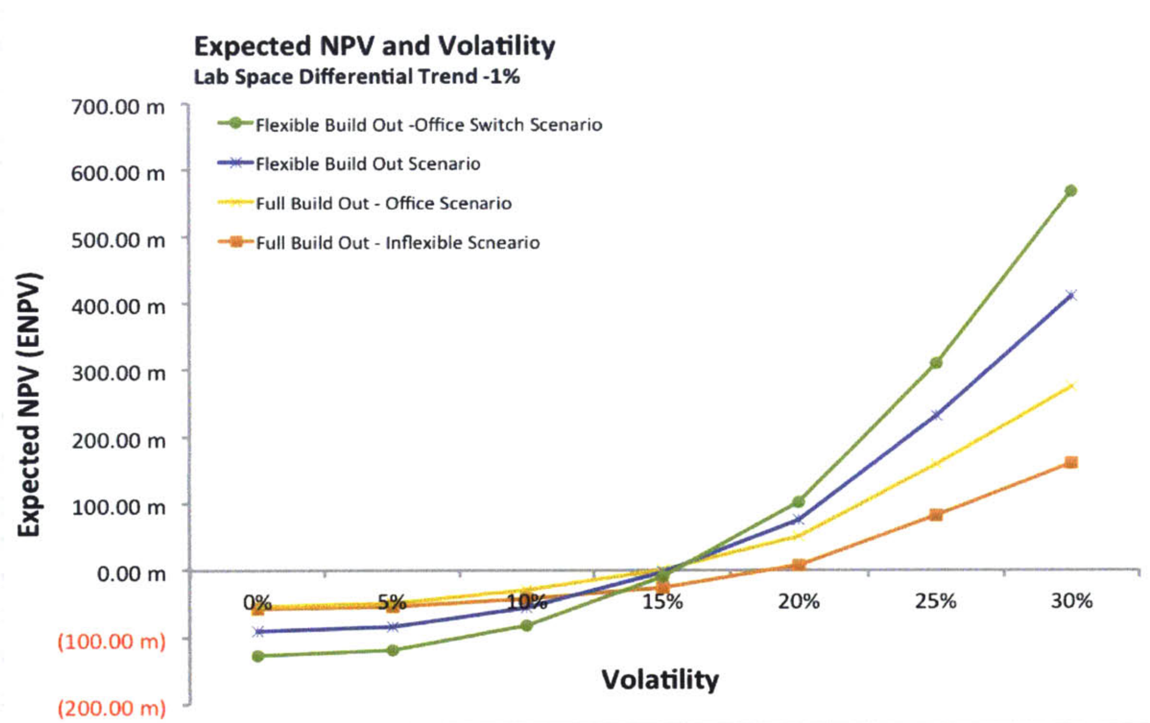

Figure 4-0-12 Sensitivity of ENPV on Market Volatility with Lab Space Differential Trend of -1%

4.5.2 Long Term Market Trend:

We also develop observations for effects of market trend on the ENPV and Project IRR. The Full Build Out (Inflexible) Scenario has consistent negative ENPV. Flexible Build Out with Office Switching Option has positive NPV through different long-term trends factors. Full Build Out – Office Scenario has the most positive ENPV among all the scenarios, but as seen in Fig 4-0-14 has lower IRR than flexible scenarios. Figure 4-0-14 also shows that flexible scenarios have consistently higher IRR among all the other scenarios.

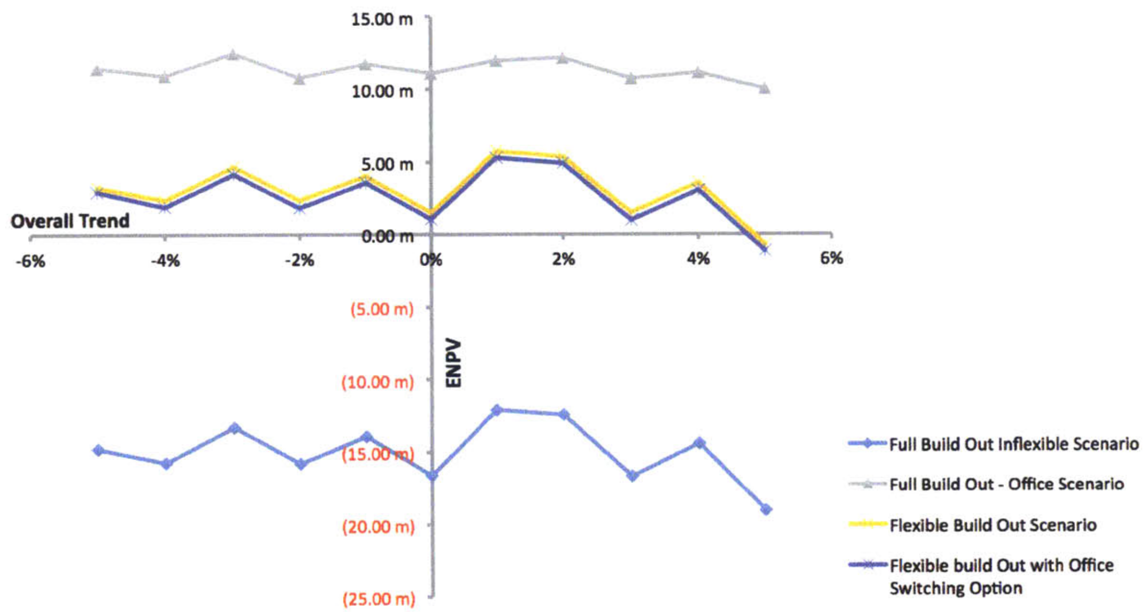

Figure 4-0-13 Sensitivity of ENPV on Long Term Market Trend

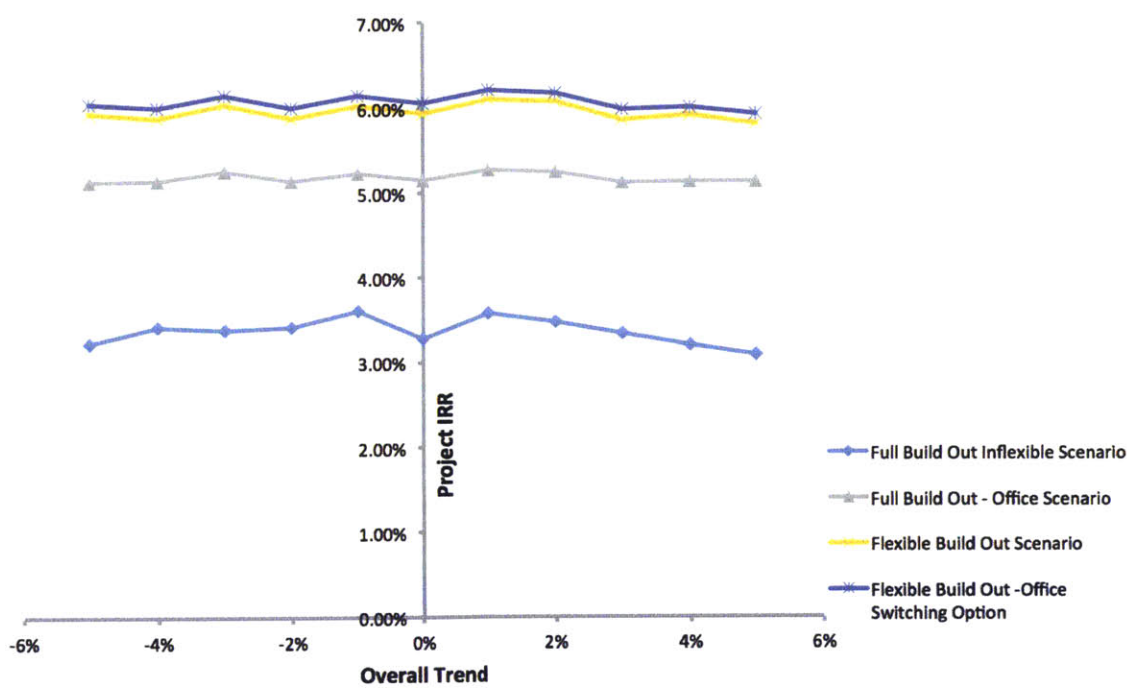

Figure 4-0-14 Sensitivity of Project IRR on Long Term Market Trend

4.5.3 Model performance under extreme market conditions:

Valuation of this flexible model under certain extreme market conditions is also developed to understand how it holds up.

We modify following uncertainty parameters from the Figure 4-0-1

Rent Cycle Phase = -2.5 Years

(Building will face downward rent movement)

Lab Space Differential Trend = -2.0%

Office Space Differential Trend = 2.0%

The results of the simulation are presented below and in VARG chart that follows:

Output: Simulation Results NPV Statistics	Full Build Out (Inflexible)	Full Build Out - Office	Flexible Build Out with Office Switching Option
Mean (ENPV)	(82.44 m)	78.21 m	18.03 m
Maximum	260.30 m	731.29 m	735.04 m
Minimum	(168.10 m)	(64.33 m)	(131.09 m)
Standard Deviation	56.04 m	83.13 m	86.85 m

Fig 4-0-11 is a VARG graph showing ex-post NPV distribution based on the aforementioned uncertainty variables. It should be noted that when these variables changes were applied to the model, option to switch use to an office use triggered during each of the year 4,14 and 24 leasing cycles.

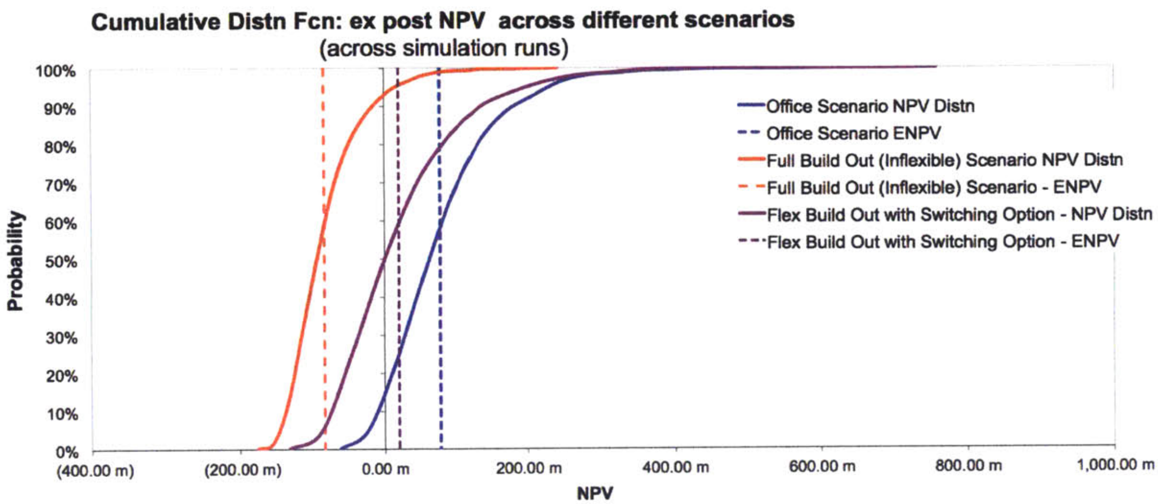

Figure 4-0-15 Cumulative Distribution Function: Comparison of Ex post NPV for different scenarios

Full Build Out – Office Scenario has the highest ENPV compared to the Full Build Out (Inflexible) Scenario and the Flexible Build Out with Office Switching Option. This is expected as the office market has a positive differential trend than the lab market. In these extreme conditions, inflexible lab scenario performs poorly due to the negative trend in lab space market and inability to switch to an office function. Flexible Build Out with Office Switching Option has positive NPV and a highest upside potential as the lab building is able to take advantage of the flexibility to attract office tenants in an adverse lab space market.

4.5.4 Valuation Conclusion

After performing the valuation, we can now determine the value of various flexibilities that are incorporated in the lab building development. The equation approach and calculation is summarized below:

Expected Value of Flexibility = ENPV (Flexible Build Out with Office Switching Option) – ENPV (Full Build Out Scenario)

Expected Value of Flexibility = \$45.11 M- \$23.33M

Expected Value of Flexibility = \$21.78 M

Expected Value of Flexibility = Approximately 93% higher than Full Build Out (Inflexible) Scenario NPV

This implies the Expected Net Present Value of various flexibilities is approximately $21.78M over the Full Build Out (Inflexible) Scenario.

5 Conclusion

Commercial lab buildings have flexibility built into them from the initial planning stages itself and these options are exercised as the building is constructed, leased and become operational. This flexibility results in higher cost for the lab building in comparison to a typical office building. During the tenant improvement stage, developers want the tenant fit outs to be as generic as possible so that they can utilize the improvements made to the space to attract the tenants in the future leasing cycles and reduce future tenant improvement costs. Future tenants are also interested in lower tenant improvements so as to reduce their future rent burden.

Value for the developer is created as the higher cost of base building is utilized to charge, on an average, higher base rents than office space. In addition, the tenant improvement allowance offered is utilized to build up tenant space. In a strong lab space market, tenant improvement allowance is amortized on top of the base rent and tenant effectively pays for the tenant improvements over a period of the lease. In a weaker space market, the developer has the option to rent the space for office use or offer competitive tenant allowance for lab use at competitive market rents to secure the lease. With the flexible lab building, the developer can reduce the downside risk if the market turns by renting the space to an office tenant and not spending additional tenant allowance or spend the additional tenant allowance to secure a lab use lease which will build out the tenant improvements to reduce tenant allowance in the next leasing cycle when the market has improved. This research has not delved into the effects of early depreciation of engineering systems but developers can create additional value in the form of tax savings by claiming depreciation of the engineering systems required in lab buildings.

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7 Appendix

Figure 7-1 - Full Build Out DCF- Deterministic Model

ssumptions (pessimistic):

Market:
owth Rate/Yr Relative to OHSTRS staff 1.25% ==> -1.66% /yr LR Same Bldg Rental Growth Rate
Asset Market:
d cap rate (trailing) 5.8700% ==> 0.068838202 = Stabilized Going-In Cap Rate (2003)
urity Cost of Capital:
e Int Rate (T-Bills) 2.90% OCC:
risk CF (constr & deferred acquisn) 0.50% ==> 3.40% Devlpt Costs (2015-2019)
ilized property asset CF 2.75% ==> 5.65% Stablzd Asset (2019...)
e-up phase asset CF 4.50% ==> 7.40% Speculative Asset (2015-2019)

	Inputs	0 2015	1 2016	2 2017	3 2018	4 2019	5 2020	6 2021	7 2022	8 2023	9 2024	10 2025	11 2026	12 2027
RandomRealizationFactor						1.02	0.89	1.20	1.22	1.08	0.89	0.89	1.05	1.03
l	2.90%													
nfrastructure		41.25 m												
ts + Carry			8.25 m	8.25 m										
ilding				37.13 m	37.13 m									
e 1-50%)	50%					18.75 m								
e 2-25%)	25%					9.38 m								
e 3-25%)	25%					9.38 m								
ment Phase Total Outflow		(41.25 m)	(8.25 m)	(45.38 m)	(37.13 m)	(37.50 m)	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
rent/SF 65$/sf with Growth at 1.25%	65.00					66.19	58.52	79.64	82.37	74.00	61.90	62.31	74.22	74.35
al revenue														
ntspace 1 (50%)	75,000	-	-	-	-	4.96 m	4.39 m	5.97 m	6.18 m	5.55 m	4.64 m	4.67 m	5.57 m	5.56 m
ntspace 2 (25%)	37,500	-	-	-	-	2.48 m	2.19 m	2.99 m	3.09 m	2.77 m	2.32 m	2.34 m	2.78 m	2.78 m
ntspace 3 (25%)	37,500	-	-	-	-	2.48 m	2.19 m	2.99 m	3.09 m	2.77 m	2.32 m	2.34 m	2.78 m	2.78 m
l		-	-	-	-	9.93 m	8.78 m	11.95 m	12.35 m	11.10 m	9.28 m	9.35 m	11.13 m	11.12 m
allowance: 8%	8%					0.79 m	0.70 m	0.96 m	0.99 m	0.89 m	0.74 m	0.75 m	0.89 m	0.89 m
cancy allowance						0.79 m	0.70 m	0.96 m	0.99 m	0.89 m	0.74 m	0.75 m	0.89 m	0.89 m
l		-	-	-	-	9.13 m	8.08 m	10.99 m	11.37 m	10.21 m	8.54 m	8.60 m	10.24 m	10.23 m
come		0	0	0	0	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
reimbursements		0	0	0	0	1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
venue		-	-	-	-	10.97 m	9.93 m	12.86 m	13.26 m	12.12 m	10.47 m	10.55 m	12.21 m	12.22 m
ng expenses per sf (Based on 2014 BOMA)	1%	11.77	11.89	12.01	12.13	12.25	12.37	12.49	12.62	12.75	12.87	13.00	13.13	13.26
sable expenses						1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
nbursable expenses:														
erating expenses						1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
		-	-	-	-	9.13 m	8.08 m	10.99 m	11.37 m	10.21 m	8.54 m	8.60 m	10.24 m	10.23 m
expenditures as (% of NOI)	15%	-	-	-	-	(1.37 m)	(1.21 m)	(1.65 m)	(1.70 m)	(1.53 m)	(1.28 m)	(1.29 m)	(1.54 m)	(1.53 m)
e 1-50%)	50%					(18.75 m)								
e 2-25%)	25%					(9.38 m)								
e 3-25%)	25%					(9.38 m)								
commissions	1%					(0.10 m)	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
CAP EX						(38.97 m)	(1.21 m)	(1.65 m)	(1.70 m)	(1.53 m)	(1.28 m)	(1.29 m)	(1.54 m)	(1.53 m)
rom Operations						(29.84 m)	9.29 m	12.64 m	13.07 m	11.74 m	9.82 m	9.89 m	11.78 m	11.77 m
rom Reversion	5.67%													
TCF (Stabilized Phase)							9.29 m	12.64 m	13.07 m	11.74 m	9.82 m	9.89 m	11.78 m	11.77 m
d Phase CFs						[illegible]	9.29 m	12.64 m	13.07 m	11.74 m	9.82 m	9.89 m	11.78 m	11.77 m
ment Phase CashFlows: IRR	-14.97%	(41.25 m)	(8.25 m)	(45.38 m)	(37.13 m)	91.00 m								
Cash Flows		(41.25 m)	(8.25 m)	(45.38 m)	(37.13 m)	(29.84 m)	9.29 m	12.64 m	13.07 m	11.74 m	9.82 m	9.89 m	11.78 m	11.77 m
	2.23%													

	13 2028	14 2029	15 2030	16 2031	17 2032	18 2033	19 2034	20 2035	21 2036	22 2037	23 2038	24 2039	25 2040
RandomRealizationFactor	1.43	1.36	1.26	1.00	0.97	0.98	0.76	0.67	0.64	0.46	0.49	0.57	0.58
l													
nfrastructure													
ts + Carry													
ilding													
e 1-50%)		24.95 m										33.21 m	
e 2-25%)		12.48 m										16.61 m	
e 3-25%)		12.48 m										16.61 m	
ment Phase Total Outflow	0.00 m	(49.91 m)	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	(66.43 m)	0.00 m
rent/SF 65$/sf with Growth at 1.25%	103.88	99.74	94.12	75.24	74.21	74.49	59.40	52.86	43.59	36.81	40.26	47.38	49.02
al revenue													
ntspace 1 (50%)	7.79 m	7.48 m	7.06 m	5.64 m	5.57 m	5.59 m	4.46 m	3.96 m	3.27 m	2.76 m	3.02 m	3.55 m	3.68 m
ntspace 2 (25%)	3.90 m	3.74 m	3.53 m	2.82 m	2.78 m	2.79 m	2.23 m	1.98 m	1.63 m	1.38 m	1.51 m	1.78 m	1.84 m
ntspace 3 (25%)	3.90 m	3.74 m	3.53 m	2.82 m	2.78 m	2.79 m	2.23 m	1.98 m	1.63 m	1.38 m	1.51 m	1.78 m	1.84 m
l	15.58 m	14.96 m	14.12 m	11.28 m	11.13 m	11.17 m	8.91 m	7.93 m	6.54 m	5.52 m	6.04 m	7.11 m	7.35 m
allowance: 8%	1.25 m	1.20 m	1.13 m	0.90 m	0.89 m	0.89 m	0.71 m	0.63 m	0.52 m	0.44 m	0.48 m	0.57 m	0.59 m
cancy allowance	1.25 m	1.20 m	1.13 m	0.90 m	0.89 m	0.89 m	0.71 m	0.63 m	0.52 m	0.44 m	0.48 m	0.57 m	0.59 m
l	14.34 m	13.76 m	12.99 m	10.38 m	10.24 m	10.28 m	8.20 m	7.29 m	6.01 m	5.08 m	5.56 m	6.54 m	6.77 m
come	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
reimbursements	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26 m
venue	16.34 m	15.79 m	15.04 m	12.45 m	12.33 m	12.39 m	10.33 m	9.45 m	8.19 m	7.28 m	7.78 m	8.78 m	9.03 m
ng expenses per sf (Based on 2014 BOMA)	13.40	13.53	13.66	13.80	13.94	14.08	14.22	14.36	14.51	14.65	14.80	14.94	15.09
sable expenses	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26 m
nbursable expenses:													
erating expenses	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26 m
	14.34 m	13.76 m	12.99 m	10.38 m	10.24 m	10.28 m	8.20 m	7.29 m	6.01 m	5.08 m	5.56 m	6.54 m	6.77 m
expenditures as (% of NOI)	(2.15 m)	(2.06 m)	(1.95 m)	(1.56 m)	(1.54 m)	(1.54 m)	(1.23 m)	(1.09 m)	(0.90 m)	(0.76 m)	(0.83 m)	(0.98 m)	(1.01 m)
e 1-50%)		(24.95 m)										(33.21 m)	
e 2-25%)		(12.48 m)										(16.61 m)	
e 3-25%)		(12.48 m)										(16.61 m)	
commissions	0.00 m	(0.15 m)	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	(0.07 m)	0.00 m
CAP EX	(2.15 m)	(52.12 m)	(1.95 m)	(1.56 m)	(1.54 m)	(1.54 m)	(1.23 m)	(1.09 m)	(0.90 m)	(0.76 m)	(0.83 m)	(67.48 m)	(1.01 m)
rom Operations	16.49 m	15.83 m	14.94 m	11.94 m	11.78 m	11.82 m	9.43 m	8.39 m	6.92 m	5.84 m	6.39 m	7.52 m	7.78 m
rom Reversion												116.93 m	
TCF (Stabilized Phase)	16.49 m	(34.08 m)	14.94 m	11.94 m	11.78 m	11.82 m	9.43 m	8.39 m	6.92 m	5.84 m	6.39 m	58.02 m	7.78 m
d Phase CFs	16.49 m	(34.08 m)	14.94 m	11.94 m	11.78 m	11.82 m	9.43 m	8.39 m	6.92 m	5.84 m	6.39 m	58.02 m	
ment Phase CashFlows: IRR													
Cash Flows	16.49 m	(34.08 m)	14.94 m	11.94 m	11.78 m	11.82 m	9.43 m	8.39 m	6.92 m	5.84 m	6.39 m	58.02 m	

(545,751,820)

PV Stabilized Asset	5.65%		119.32 m
ro PV Acquisition & Fees	3.40%	(41.25 m)	
ro PV Construction (hard & soft)	3.40%	(112.39 m)	
ro PV Spec Asset	7.40%	89.68 m	
vlpt Project as of Time Zero		(63.75 m)	

Input Assumptions (pessimistic):

Rental Market:
Rent Growth Rate/Yr Relative to OHSTRS staff: 1.25% ==> -1.01% /yr LR Same Bldg Rental Growth Rate
Resale Asset Market: 0.045294738 = Stabilized Going In Cap Rate (2003)
Terminal cap rate (trailing): 5.6700% ==>
Opportunity Cost of Capital:
Riskfree Int Rate (T-Bills): 2.90% — OCC:
RP low risk CF (constr & deferred acquisn): 0.50% ==> 3.40% Devlpt Costs (2015-2019)
RP stabilized property asset CF: 2.75% ==> 6.65% Stabilzd Asset (2019...)
RP lease-up phase asset CF: 4.50% ==> 7.40% Speculative Asset (2015-2019)

	Inputs	0 2015	1 2016	2 2017	3 2018	4 2019	5 2020	6 2021	7 2022	8 2023	9 2024	10 2025	11 2026	12 2027
RandomRealizationFactor						1.00	0.93	1.08	1.24	1.17	1.10	1.26	1.33	1.12
Inflation	2.90%													
Land + Infrastructure		41.25 m												
Soft Costs + Carry			8.25 m	8.25 m										
Base Building				24.75 m	24.75 m									
TI (space 1-50%)	50%					4.50 m					5.19 m			
TI (space 2-25%)	25%					2.25 m					2.60 m			
TI (space 3-25%)	25%					2.25 m					2.60 m			
Development Phase Total Outflow		(41.25 m)	(8.25 m)	(33.00 m)	(24.75 m)	(9.00 m)	0.00 m	0.00 m	0.00 m	0.00 m	10.38 m	0.00 m	0.00 m	0.00 m
Market rent/SF 50$/sf with Growth at 1%	55.00					54.82	51.89	60.94	70.74	67.81	64.42	74.40	79.98	68.16
Potential revenue														
Gross rent space 1 (50%)	75,000	-	-	-	-	4.11 m	3.89 m	4.57 m	5.31 m	5.09 m	4.83 m	5.58 m	6.00 m	5.11 m
Gross rent space 2 (25%)	37,500	-	-	-	-	2.06 m	1.95 m	2.29 m	2.65 m	2.54 m	2.42 m	2.79 m	3.00 m	2.56 m
Gross rent space 3 (25%)	37,500	-	-	-	-	2.06 m	1.95 m	2.29 m	2.65 m	2.54 m	2.42 m	2.79 m	3.00 m	2.56 m
Total PGI		-	-	-	-	8.22 m	7.78 m	9.14 m	10.61 m	10.17 m	9.66 m	11.16 m	12.00 m	10.22 m
Vacancy allowance: 8%	8%					0.66 m	0.62 m	0.73 m	0.85 m	0.81 m	0.77 m	0.89 m	0.96 m	0.82 m
Total vacancy allowance						0.66 m	0.62 m	0.73 m	0.85 m	0.81 m	0.77 m	0.89 m	0.96 m	0.82 m
Total EGI		-	-	-	-	7.57 m	7.16 m	8.41 m	9.76 m	9.36 m	8.89 m	10.27 m	11.04 m	9.41 m
Other income		0	0	0	0	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
Expense reimbursements		0	0	0	0	1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
Total Revenue		-	-	-	-	9.40 m	9.02 m	10.28 m	11.65 m	11.27 m	10.82 m	12.22 m	13.01 m	11.40 m
Operating expenses per sf (Based on 2014 BOMA)	1%	11.77	11.89	12.01	12.13	12.25	12.37	12.49	12.62	12.75	12.87	13.00	13.13	13.26
Reimbursable expenses						1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
Nonreimbursable expenses:														
Total operating expenses						1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
NOI		-	-	-	-	7.57 m	7.16 m	8.41 m	9.76 m	9.36 m	8.89 m	10.27 m	11.04 m	9.41 m
Capital expenditures as (% of NOI)	15%	-	-	-	-	(1.13 m)	(1.07 m)	(1.26 m)	(1.46 m)	(1.40 m)	(1.33 m)	(1.54 m)	(1.66 m)	(1.41 m)
TI (space 1-50%)	50%					(4.50 m)					(5.19 m)			
TI (space 2-25%)	25%					(2.25 m)					(2.60 m)			
TI (space 3-25%)	25%					(2.25 m)					(2.60 m)			
Leasing commissions	1%					(0.08 m)					(0.10 m)			
TOTAL CAP EX						(10.22 m)	(1.07 m)	(1.26 m)	(1.46 m)	(1.40 m)	(11.81 m)	(1.54 m)	(1.66 m)	(1.41 m)
PBTCF from Operations						(2.65 m)	8.24 m	9.67 m	11.23 m	10.76 m	10.22 m	11.81 m	12.69 m	10.82 m
PBTCF From Reversion	5.67%													
Total PBTCF (Stabilized Phase)							8.24 m	9.67 m	11.23 m	10.76 m	20.61 m	11.81 m	12.69 m	10.82 m
Stabilized Phase CFs						(159.10 m)	8.24 m	9.67 m	11.23 m	10.76 m	20.61 m	11.81 m	12.69 m	10.82 m
Development Phase Cash Flows: IRR	14.65%	(41.25 m)	(8.25 m)	(33.00 m)	(24.75 m)	155.45 m								
Overall Cash Flows		(41.25 m)	(8.25 m)	(33.00 m)	(24.75 m)	(2.65 m)	8.24 m	9.67 m	11.23 m	10.76 m	20.61 m	11.81 m	12.69 m	10.82 m
IRR	7.44%													
NPV														
	$23,495,923													

	13 2028	14 2029	15 2030	16 2031	17 2032	18 2033	19 2034	20 2035	21 2036	22 2037	23 2038	24 2039	25 2040
RandomRealizationFactor	0.82	0.81	0.80	0.91	1.20	1.37	1.21	1.21	1.03	1.05	0.70	0.83	0.80
Inflation													
Land + Infrastructure													
Soft Costs + Carry													
Base Building													
TI (space 1-50%)		5.99 m					6.91 m					7.97 m	
TI (space 2-25%)		2.99 m					3.45 m					3.99 m	
TI (space 3-25%)		2.99 m					3.45 m					3.99 m	
Development Phase Total Outflow	0.00 m	(11.98 m)	0.00 m	0.00 m	0.00 m	0.00 m	13.82 m	0.00 m	0.00 m	0.00 m	0.00 m	(15.94 m)	0.00 m
Market rent/SF 50$/sf with Growth at 1%	50.65	50.18	50.31	58.20	77.50	89.34	79.92	81.27	69.89	71.90	48.81	44.75	42.87
Potential revenue													
Gross rent space 1 (50%)	3.80 m	3.76 m	3.77 m	4.37 m	5.81 m	6.70 m	5.99 m	6.10 m	5.24 m	5.39 m	3.66 m	3.36 m	3.22m
Gross rent space 2 (25%)	1.90 m	1.88 m	1.89 m	2.18 m	2.91 m	3.35 m	3.00 m	3.05 m	2.62m	2.70 m	1.83 m	1.68 m	1.61 m
Gross rent space 3 (25%)	1.90 m	1.88 m	1.89 m	2.18 m	2.91 m	3.35 m	3.00 m	3.05 m	2.62m	2.70 m	1.83 m	1.68 m	1.61 m
Total PGI	7.60 m	7.53 m	7.55 m	8.73 m	11.62m	13.40 m	11.99 m	12.19 m	10.48 m	10.78 m	7.32m	6.71 m	6.43m
Vacancy allowance: 8%	0.61 m	0.60 m	0.60 m	0.70 m	0.93m	1.07 m	0.96m	0.98 m	0.84m	0.86 m	0.59 m	0.54 m	0.51 m
Total vacancy allowance	0.61 m	0.60 m	0.60 m	0.70 m	0.93 m	1.07 m	0.96 m	0.98 m	0.84m	0.86 m	0.59 m	0.54 m	0.51 m
Total EGI	6.99 m	6.92 m	6.94 m	8.03 m	10.69 m	12.33 m	11.03 m	11.22 m	9.64 m	9.92 m	6.74 m	6.18 m	5.92m
Other income	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
Expense reimbursements	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26m
Total Revenue	9.00 m	8.95 m	8.99 m	10.10 m	12.79 m	14.44 m	13.16 m	13.37 m	11.82m	12.12 m	8.96 m	8.42 m	8.18 m
Operating expenses per sf (Based on 2014 BOMA)	13.40	13.53	13.66	13.80	13.94	14.08	14.22	14.36	14.51	14.65	14.80	14.94	15.09
Reimbursable expenses	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26m
Nonreimbursable expenses:													
Total operating expenses	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26m
NOI	6.99 m	6.92 m	6.94 m	8.03 m	10.69 m	12.33 m	11.03 m	11.22 m	9.64 m	9.92 m	6.74 m	6.18 m	5.92m
Capital expenditures as (% of NOI)	(1.05 m)	(1.04 m)	(1.04 m)	(1.20 m)	(1.60 m)	(1.85 m)	(1.65 m)	(1.68 m)	(1.45 m)	(1.49 m)	(1.01 m)	(0.93 m)	(0.89 m)
TI (space 1-50%)		(5.99 m)					(6.91 m)					(7.97 m)	
TI (space 2-25%)		(2.99 m)					(3.45 m)					(3.99 m)	
TI (space 3-25%)		(2.99 m)					(3.45 m)					(3.99 m)	
Leasing commissions		(0.08 m)					(0.12 m)					(0.07 m)	
TOTAL CAP EX	(1.05 m)	(13.09 m)	(1.04 m)	(1.20 m)	(1.60 m)	(1.85 m)	(15.59 m)	(1.68 m)	(1.45 m)	(1.49 m)	(1.01 m)	(16.94 m)	(0.89 m)
PBTCF from Operations	8.04 m	7.96 m	7.98 m	9.24 m	12.30 m	14.18 m	12.68 m	12.90 m	11.09 m	11.41 m	7.75 m	7.10 m	6.80 m
PBTCF From Reversion												102.26 m	
Total PBTCF (Stabilized Phase)	8.04 m	(4.01 m)	7.98 m	9.24 m	12.30 m	14.18 m	26.50 m	12.90 m	11.09 m	11.41 m	7.75 m	93.42 m	6.80 m
Stabilized Phase CFs	8.04 m	(4.01 m)	7.98 m	9.24 m	12.30 m	14.18 m	26.50 m	12.90 m	11.09 m	11.41 m	7.75 m	93.42 m	
Development Phase Cash Flows: IRR													
Overall Cash Flows	8.04 m	(4.01 m)	7.98 m	9.24 m	12.30 m	14.18 m	26.50 m	12.90 m	11.09 m	11.41 m	7.75 m	93.42 m	

Time T PV Stabilized Asset	6.65%		156.12 m
Time Zero PV Acquisition & Fees	3.40%	(41.25 m)	
Time Zero PV Construction (hard&soft)	3.40%	(68.00 m)	
Time Zero PV Spec Asset	7.40%	117.34 m	
NPV Devlpt Project as of Time Zero		8.10 m	

Figure 7-2 Full Build Out – Office Option DCF - Deterministic Model

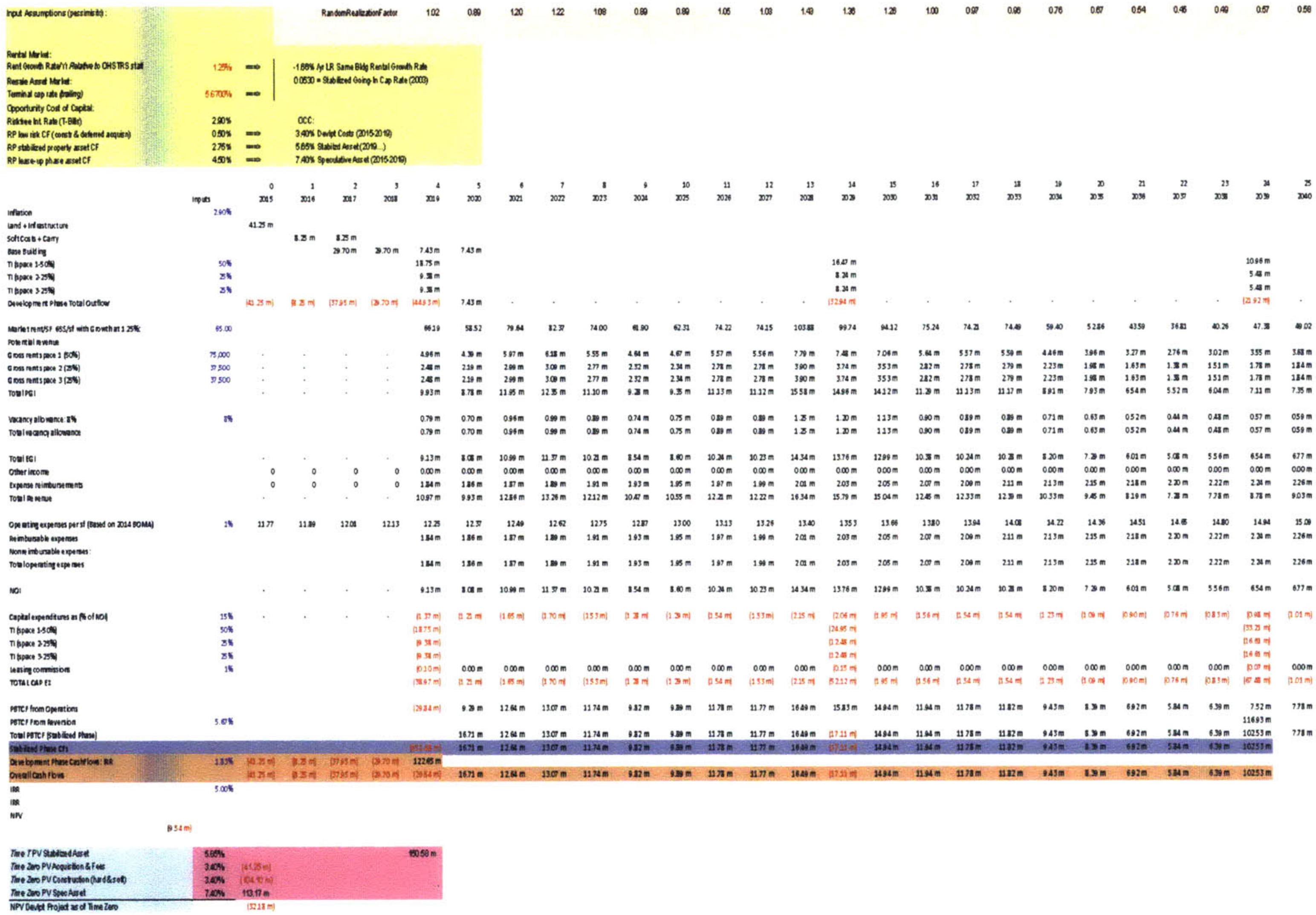

Figure 7-3 Flex Build Out Model with Uncertainty

Figure 7-4 Flex Build Out Model with Office Switch Option

Input Assumptions (pessimistic):
Leasing Cycle Year 4-Year 13 — Lab Space
Leasing Cycle Year 14-Year 23 — Lab Space

Rental Market: 2.80%
Rent Growth Rate/Yr Relative to OHSTRS stat 1.25% ⟹ -1.86% /yr LR Same Bldg Rental Growth Rate
Resale Asset Market: 0.057958958 = Stabilized Going-In Cap Rate (2003)
Terminal cap rate (trailing) 5.6700% ⟹
Opportunity Cost of Capital:
Riskfree Int Rate (T-Bills) 2.90% — OCC:
RP low risk CF (const & deferred acquisn) 0.50% ⟹ 3.40% Devlpt Costs (2015-2019)
RP stabilized property asset CF 2.75% ⟹ 5.66% Stabilzd Asset (2019...)
RP lease-up phase asset CF 4.50% ⟹ 7.40% Speculative Asset (2015-2019)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
					Leasing Cycle 1										Leasing Cycle 2											
RandomRealizationFactor Lab Space					1.02	0.89	1.20	1.22	1.08	0.89	0.89	1.05	1.03	1.43	1.36	1.26	1.00	0.97	0.96	0.76	0.67	0.54	0.46	0.49	0.57	0.58
RandomRealizationFactor Office Space					1.17	1.10	1.26	1.33	1.12	0.82	0.81	0.80	0.91	1.20	1.37	1.21	1.21	1.03	1.05	0.70	0.63	0.60	0.53	0.64	0.81	0.83
		Lab Space	Office Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Lab Space	Office Space	Lab Space	Lab Space	Lab Space

	Inputs	0 (2015)	1 (2016)	2 (2017)	3 (2018)	4 (2019)	5 (2020)	6 (2021)	7 (2022)	8 (2023)	9 (2024)	10 (2025)	11 (2026)	12 (2027)
Inflation	2.60%													
Land + Infrastructure		41.25 m												
Soft Costs + Carry			8.25 m	8.25 m										
Base Building				29.70 m	29.70 m	7.43 m	7.43 m							
TI (space 1-50%)	50%					18.75 m								
TI (space 2-25%)	25%					9.38 m								
TI (space 3-25%)	25%					9.38 m								
Development Phase Total Outflow		(41.25 m)	(8.25 m)	(37.95 m)	(29.70 m)	(44.93 m)	7.43 m	-	-	-	-	-	-	-
Market rent/SF 65$/sf with Growth at 1.25%:	65.00					66.19	58.52	79.64	82.37	74.00	81.90	62.31	74.22	74.15
Market rent/SF for Office 50$/sf with Growth at 1%:	55.00					64.52	61.30	70.79	76.10	64.86	48.20	47.75	47.87	55.38
Potential revenue														
Gross rent space 1 (50%)	75,000	-	-	-	-	4.84 m	4.60 m	5.31 m	5.71 m	4.86 m	3.61 m	3.58 m	3.59 m	4.15 m
Gross rent space 2 (25%)	37,500	-	-	-	-	2.42 m	2.30 m	2.65 m	2.85 m	2.43 m	1.81 m	1.79 m	1.80 m	2.08 m
Gross rent space 3 (25%)	37,500	-	-	-	-	2.42 m	2.30 m	2.65 m	2.85 m	2.43 m	1.81 m	1.79 m	1.80 m	2.08 m
Total PGI		-	-	-	-	9.68 m	9.19 m	10.62 m	11.42 m	9.73 m	7.23 m	7.16 m	7.18 m	8.31 m
Vacancy allowance: 8%	8%					0.79 m	0.70 m	0.96 m	0.99 m	0.89 m	0.74 m	0.75 m	0.89 m	0.89 m
Total vacancy allowance						0.79 m	0.70 m	0.96 m	0.99 m	0.89 m	0.74 m	0.75 m	0.89 m	0.89 m
Total EGI		-	-	-	-	8.88 m	8.49 m	9.66 m	10.43 m	8.84 m	6.49 m	6.41 m	6.29 m	7.42 m
Other income		0	0	0	0	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
Expense reimbursements		0	0	0	0	1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
Total Revenue		-	-	-	-	10.72 m	10.35 m	11.54 m	12.32 m	10.75 m	8.42 m	8.36 m	8.26 m	9.41 m
Operating expenses per sf (Based on 2014 BOMA)	1%	11.77	11.89	12.01	12.13	12.25	12.37	12.49	12.62	12.75	12.87	13.00	13.13	13.26
Reimbursable expenses						1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
Nonreimbursable expenses:														
Total operating expenses						1.84 m	1.86 m	1.87 m	1.89 m	1.91 m	1.93 m	1.95 m	1.97 m	1.99 m
NOI		-	-	-	-	8.88 m	8.49 m	9.66 m	10.43 m	8.84 m	6.49 m	6.41 m	6.29 m	7.42 m
Capital expenditures as (% of NOI)	15%	-	-	-	-	(1.33 m)	(1.27 m)	(1.45 m)	(1.56 m)	(1.33 m)	(0.97 m)	(0.96 m)	(0.94 m)	(1.11 m)
TI (space 1-50%)	50%					(4.50 m)								
TI (space 2-25%)	25%					(2.25 m)								
TI (space 3-25%)	25%					(2.25 m)								
Leasing commissions	1%					(0.10 m)	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
TOTAL CAP EX						(10.43 m)	(1.27 m)	(1.45 m)	(1.56 m)	(1.33 m)	(0.97 m)	(0.96 m)	(0.94 m)	(1.11 m)
PBTCF from Operations						(1.54 m)	9.77 m	11.11 m	11.99 m	10.17 m	7.46 m	7.38 m	7.23 m	8.53 m
PBTCF From Reversion	5.67%													
Total PBTCF (Stabilized Phase)							17.39 m	11.11 m	11.99 m	10.17 m	7.46 m	7.38 m	7.23 m	8.53 m
Stabilized Phase CFs						[illegible]	17.39 m	11.11 m	11.99 m	10.17 m	7.46 m	7.38 m	7.23 m	8.53 m
Development Phase Cash Flows: IRR	8.61%	(41.25 m)	(8.25 m)	(37.95 m)	(29.70 m)	144.98 m								
Overall Cash Flows		(41.25 m)	(8.25 m)	(37.95 m)	(29.70 m)	(1.54 m)	17.39 m	11.11 m	11.99 m	10.17 m	7.46 m	7.38 m	7.23 m	8.53 m
IRR	6.21%													
IRR														
NPV														

	13 (2028)	14 (2029)	15 (2030)	16 (2031)	17 (2032)	18 (2033)	19 (2034)	20 (2035)	21 (2036)	22 (2037)	23 (2038)	24 (2039)	25 (2040)
TI (space 1-50%)		16.47 m										10.96 m	
TI (space 2-25%)		8.24 m										5.48 m	
TI (space 3-25%)		8.24 m										5.48 m	
Development Phase Total Outflow	-	(32.94 m)	-	-	-	-	-	-	-	-	-	(21.92 m)	-
Market rent/SF 65$/sf with Growth at 1.25%:	103.88	99.74	94.12	75.24	74.21	74.49	59.40	52.86	43.59	36.81	40.26	47.38	49.02
Market rent/SF for Office 50$/sf with Growth at 1%:	73.74	85.01	76.05	77.33	66.50	68.41	46.45	42.58	40.79	36.20	44.90	56.82	58.92
Gross rent space 1 (50%)	5.53 m	7.48 m	7.06 m	5.64 m	5.57 m	5.59 m	4.46 m	3.96 m	3.27 m	2.76 m	3.02 m	4.26 m	4.42 m
Gross rent space 2 (25%)	2.77 m	3.74 m	3.53 m	2.82 m	2.78 m	2.79 m	2.23 m	1.98 m	1.63 m	1.38 m	1.51 m	2.13 m	2.21 m
Gross rent space 3 (25%)	2.77 m	3.74 m	3.53 m	2.82 m	2.78 m	2.79 m	2.23 m	1.98 m	1.63 m	1.38 m	1.51 m	2.13 m	2.21 m
Total PGI	11.06 m	14.96 m	14.12 m	11.29 m	11.13 m	11.17 m	8.91 m	7.93 m	6.54 m	5.52 m	6.04 m	8.52 m	8.84 m
Vacancy allowance: 8%	1.25 m	1.20 m	1.13 m	0.90 m	0.89 m	0.89 m	0.71 m	0.63 m	0.52 m	0.44 m	0.48 m	0.57 m	0.59 m
Total vacancy allowance	1.25 m	1.20 m	1.13 m	0.90 m	0.89 m	0.89 m	0.71 m	0.63 m	0.52 m	0.44 m	0.48 m	0.57 m	0.59 m
Total EGI	9.81 m	13.76 m	12.99 m	10.38 m	10.24 m	10.28 m	8.20 m	7.29 m	6.01 m	5.08 m	5.56 m	7.95 m	8.25 m
Other income	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m
Expense reimbursements	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26 m
Total Revenue	11.82 m	15.79 m	15.04 m	12.45 m	12.33 m	12.39 m	10.33 m	9.45 m	8.19 m	7.28 m	7.78 m	10.20 m	10.51 m
Operating expenses per sf (Based on 2014 BOMA)	13.40	13.53	13.66	13.80	13.94	14.08	14.22	14.36	14.51	14.65	14.80	14.94	15.09
Reimbursable expenses	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26 m
Total operating expenses	2.01 m	2.03 m	2.05 m	2.07 m	2.09 m	2.11 m	2.13 m	2.15 m	2.18 m	2.20 m	2.22 m	2.24 m	2.26 m
NOI	9.81 m	13.76 m	12.99 m	10.38 m	10.24 m	10.28 m	8.20 m	7.29 m	6.01 m	5.08 m	5.56 m	7.95 m	8.25 m
Capital expenditures as (% of NOI)	(1.47 m)	(2.06 m)	(1.95 m)	(1.56 m)	(1.54 m)	(1.54 m)	(1.23 m)	(1.09 m)	(0.90 m)	(0.76 m)	(0.83 m)	(1.19 m)	(1.24 m)
TI (space 1-50%)		(16.47 m)										(7.97 m)	
TI (space 2-25%)		(8.24 m)										(3.99 m)	
TI (space 3-25%)		(8.24 m)										(3.99 m)	
Leasing commissions	0.00 m	(0.15 m)	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	0.00 m	(0.08 m)	0.00 m
TOTAL CAP EX	(1.47 m)	(35.15 m)	(1.95 m)	(1.56 m)	(1.54 m)	(1.54 m)	(1.23 m)	(1.09 m)	(0.90 m)	(0.76 m)	(0.83 m)	(17.22 m)	(1.24 m)
PBTCF from Operations	11.29 m	15.83 m	14.94 m	11.94 m	11.78 m	11.82 m	9.43 m	8.39 m	6.92 m	5.84 m	6.39 m	9.15 m	9.49 m
PBTCF From Reversion												142.58 m	
Total PBTCF (Stabilized Phase)	11.29 m	(17.11 m)	14.94 m	11.94 m	11.78 m	11.82 m	9.43 m	8.39 m	6.92 m	5.84 m	6.39 m	139.81 m	9.49 m
Stabilized Phase CFs	11.29 m	(17.11 m)	14.94 m	11.94 m	11.78 m	11.82 m	9.43 m	8.39 m	6.92 m	5.84 m	6.39 m	139.81 m	
Overall Cash Flows	11.29 m	(17.11 m)	14.94 m	11.94 m	11.78 m	11.82 m	9.43 m	8.39 m	6.92 m	5.84 m	6.39 m	139.81 m	

$7,397,754

Time T PV Stabilized Asset	5.65%		144.69 m
Time Zero PV Acquisition & Fees	3.40%	(41.25 m)	
Time Zero PV Construction (hard&soft)	3.40%	(104.10 m)	
Time Zero PV Spec Asset	7.40%	108.75 m	
NPV Devlpt Project as of Time Zero		(36.60 m)	

(18.75 m)

Interview Questions:

- How do you decide what kind of users should you plan the lab building for?
- How is lab space design typically guided in terms of planning for users' needs?
- What if any uncertainties and/or contingencies are explicitly considered in this process?
- What are the most critical factors for the optimal performance of the lab Buildings that should be part of building at the onset for Wet labs and Dry labs?
- Are opportunities for flexibility in the design and usage of the space typically considered, and if so, which and how?
- Is structural or physical flexibility in terms of expanding the building or changing the use of the building in the future ever considered during the project planning stages?
- What kind of future developments concerns you in terms of lab space demand?
- Are their functional, programmatic, logistical or regulatory constraints that hamper planning for uncertainty and flexibility in biotech space design?
- What are the typical building cost estimate for the development of lab building?
- In comparison to commercial office development, What are your big cost items in the development of lab buildings that significantly make the lab development more capital intensive.