Appendix A: Experience, Personnel, and Adequacy of Resources

Our project team is highly qualified to carry out this effort.

Dr. William Sullivan is Professor of Landscape Architecture at the University of Illinois in Urbana-Champaign. He holds a Ph.D. from the University of Michigan with a concentration in Environment and Behavior. Over the past fifteen years, Sullivan has been one of the most productive scholars in the field of urban forestry. Along with his colleagues, he has produced ground-breaking research on the social benefits of urban forests. His work has shown the connection between everyday exposure to green spaces and increased strength of communities, lower levels of crime, and reduced levels of domestic violence. Sullivan has been tremendously effective at disseminating findings of his NUCFAC supported work. These findings have reached tens of millions of individuals in North America and around the world. Because of his research on urban forests, Sullivan has been named to the National Institute of Medicine's *Roundtable on Environmental Health Science, Research, and Medicine*.

Bin Jiang is a third-year doctorial student in the Department of Landscape Architecture at University of Illinois. He holds a Masters of Landscape Architecture degree from Beijing University with a concentration on Urban Green Space and Environmental Sustainability. Over the past ten years, Mr. Jiang has worked as an associate urban designer and landscape architect for three leading Landscape Architecture and Urban planning design firms: Turenscape, EADW and Peter Walker and Partners and has won ten international design competitions for landscape planning of urban green space. In 2005, Mr. Jiang won the Honor Award of Planning and Analysis of the ASLA (American Society of Landscape Architects) for his contribution to a research project on urban green space: *Growth Patterns of Taizhou City Based on it's Ecological Infrastructure*. Mr. Jiang has worked with Professor Sullivan for three years on several research projects examining the social and environmental benefits of urban forests.

David M. Buchner is the *Shahid and Ann Carlson Khan Professor* in Applied Health Sciences in the Department of Kinesiology and Community Health at the University of Illinois. He holds a B.A. from Harvard, an M.D. from the University of Kansas, and a M.P.H from the University of Washington. At Illinois, Professor Buchner directs the Masters of Public Health Program and conducts research on community-level approaches to chronic disease prevention, particularly approaches to promoting physical activity. From 1999 to 2008, he directed the Physical Activity and Health Branch at the Centers for Disease Control and Prevention, where he helped lead national initiatives to promote physical activity. Professor Buchner received Charles C. Shepard Science Award for Prevention and Control from the CDC and is a Fellow in the Gerontological Society of America and in the American College of Sports Medicine. An incredibly productive scholar, Dr. Buchner has more than 150 scientific publications.

Scott Maco is the Manager of Urban Ecosystem Services at Davey Tree where he provides management and leadership for the Urban Forest Technology working group at the Davey Institute. His primary focus is on applied research and development of urban forest assessment and management tools. Specifically, Scott works to create new technologies that provide better access and understanding of trees' environmental benefits and how ecosystem services can be enhanced by managing urban forest structure.

Scott has more than 13 years of experience in planning, design, and implementation of urban forestry enhancement projects and developing the tools to facilitate effective resource management.

Building on his experience working for the USDA Forest Service's Center for Urban Forest Research, Scott continues to lead development of the i-Tree Tools software suite. Additional, ongoing cooperative research projects include development of a national pest detection and reporting protocol, tree suitability modeling, and web-accessible tree benefit calculators.

Scott Maco holds a Master of Science in Horticulture and Agronomy from the University of California, Davis and a Bachelor of Science in Urban Forestry from the College of Forest Resources, University of Washington.

Also at Davey Tree

Mike Binkley - Research and Development Analyst, GIS

Mike Binkley is a Geographic Information Systems (GIS) specialist with 15 years of experience whose primary responsibility is the application of new technology to Davey endeavors. Past projects include the use of GIS analysis to resolve environmental and natural resource management issues, the development of Davey's GIS-based Asset Manager software and handheld field data collection software, as well as online mapping and web design, GPS vehicle tracking, satellite derived land cover classification, and cartographic design. As such, he strives to maintain extensive knowledge of contemporary GIS software as well as common operating system software and hardware platforms. In addition, he teaches GIS programming part-time at Kent State University. Mr. Binkley holds a Master of Arts in Geography – GIS from Kent State University and a Bachelor of Science with Honors in Natural Resource Conservation with minors in Climatology and Geography from the same institution.

Lianghu Tian - Research and Development Analyst, IT

Lianghu Tian brings 14 years of expertise in information technology, digital image processing, remote sensing and Geographic Information Systems (GIS) to Davey. Currently, Lianghu is a Research & Development Analyst. He manages IT activities, application design, and research and development projects for The Davey Institute. Tian specializes in computer programming, network administration, SQL database server administration, remote sensing satellite image processing, neural networks, web design and GIS. Before joining Davey, Tian completed various research projects in the United States (including Managing Urban Sprawl and Land Resource Changes by Remote Sensing and Geographic Information Systems; Great American Secchi Dip-in Program and Satellite Image Processing and Geographic Information Systems), as well as research projects in China including Gold Mine Detection by Remote Sensing, Urban Information Systems and Land Resource Information Systems. He has published numerous articles in his fields of expertise and has won several distinguished awards. Tian holds a PhD from Kent State University, a Master of Arts from Kent State University and earned both Master and Bachelor of Science degrees in information and image processing and remote sensing from Zhejiang University in China.

Al Zelaya - Research Urban Forester

Al Zelaya is a Research Urban Forester for The Davey Tree Expert Company. His primary responsibilities include development, research, training, website administration and providing technical support for urban forestry environmental service projects. His focus includes support and integration tasks related to i-Tree, IPED (pest detection protocol) and SDAP (storm damage assessment protocols) initiatives. Al has 10 years experience working in urban forestry, arboriculture and natural areas management. Mr. Zelaya has a Bachelor of Arts Degree from DePaul University in Chicago, and is completing a master's degree in Natural Resources and Environmental Sciences from the University of Illinois. Al is an ISA certified arborist and a member of the Society of Municipal Arborists and the International Society of Arboriculture.

David Ellingsworth – Lead i-Tree Programmer

David Ellingsworth is a lead programmer for the i-Tree development team. His primary responsibilities include the development and maintenance of i-Tree Streets. David has experience developing with variety of programming languages including Java, .Net, C++, C, PHP, Perl, HTML, and CSS. He holds a Bachelors of Science in Computer Science from The University of Akron, an Associates of Business in Software Development and an Associates of Business in Network Communications Technology from Lorain County Community College. Prior to joining the i-Tree team, he developed web-based applications in .Net and ASP for Software Answers.

Michael Kerr – Lead i-Tree Programmer

Michael Kerr is a lead programmer for the i-Tree development team. His primary responsibilities include development for i-Tree Eco, i-Tree Hydro, and i-Tree's Pocket PC applications. He also develops and maintains the i-Tree Installation package. Michael studied Computer Science at Youngstown State University. He specializes in programming C#, VB.NET, VB6, and VBA applications along with configuration, installation, and software maintenance. Past projects include converting i-Tree Eco and i-Tree Streets to the .NET Compact Framework, the i-Tree Eco Report Generator, and a Pocket PC communication library.

We look forward to sharing the findings of this work with the citizens of the United States, policy-makers, the media, the scientific community, and professional organizations. We expect the results will add considerably to the evidence demonstrating the necessity for having healthy urban and community forests in every community across the land.

Appendix B: Literature Review

In this review, we examine two lines of research. First, we explore the pathways by which the experience of stress impacts physical health. Second, we examine the evidence showing that contact with urban green spaces reduce stress levels.

The Experience of Stress

Humans experience stress in response to a situation that challenges or threatens well-being (Ulrich, et al, 1991; Hartig et al, 1996; Grahn & Stigsdotter, 2003; Maller et al., 2005; Groene-wegen et al., 2006; Tzoulas et al., 2007). From a biological perspective, stress activates two interrelated physiological systems: the sympathetic-adrenal medullary system (SAM) and the hypothalamic-pituitary-adrenocortical axis (HPA).

The SAM system reacts to threats or emergencies with increased secretion of the hormone epinephrine in the form of epinephrine and norepinephrine (Levi, 1972; Schommer, Hellhammer, & Kirschbaum, 2003; Gold, Zakowski, Valdimarsdottir, Bovbjerg, 2003). Excessive discharge of these substances is known to induce many of the pathogenic states associated with the perception of stress including cardiovascular effects such as increased blood pressure and heart rate (McCubbin, Richardson, Obrist, Kezer, & Langer, 1980) and the development of variations in normal heart rhythms (ventricular arrhythmias) which have been shown to be a powerful and independent predictor of heart disease (c.f. Routledge, Chowdhary, Townend, 2002).

The HPA axis reacts to threat or emergencies with increased secretion of two hormones. During a person's initial reaction to a threat or emergency, the anterior pituitary gland secretes adrenocorticotrophic hormone, which then activates the adrenal cortex to secrete additional cortisol. The output of corticosteroids remains high but stable until the threat has been resolved or when exhaustion occurs at which time a breakdown results in illness or ultimately death (Cohen, Kessler, & Gordon, 1997). An integrative model of stress is presented in Figure 1. This model, taken from Cohen, Kessler, & Gordon (1997), describes the sequential relations between the central components of a stressful experience. As the authors describe it:

> When confronting environmental demands, people evaluate whether the demands pose a potential threat and whether sufficient adaptive capacities are available to cope with them. If they find the environmental demands taxing or threatening, and at the same time view their coping resources as inadequate, they perceive themselves as under stress. The appraisal of stress is presumed to result in negative emotional states. If extreme, these emotional states may … trigger behavioral or physiological responses that put a person under risk for psychiatric and physical illness.

There are several valid physiological of indicators of stress that have been used in thousands of studies. These indicators include: electroencephalography (EEG), electromyograhy (EMG), blood volume (BVP), blood pressure (BP), and heart rate variability (HR) (see for instance: Andreassi 2007, Cacippo et al., 2007, and Stern et al., 2001).

Stress and Illness

For humans, stressors have been shown to influence the pathogenesis of physical disease by causing negative psychological states. That is, stressful events promote disease by producing states such as depression or anxiety that in turn effect biological processes that promote disease (c.f. Chorot, & Sandin, 1994; Butow, et al., 2000).

The primary biological pathway linking emotions to disease is via the so-called stress hormones (Cohen, Kessler, & Gordon, 1997). Cohen and his colleagues state that "hormonal responses associated with stressful experiences included elevations in the catecholamines epinephrine and norepinephrine secreted by the adrenal medulla, in cortisol secreted by the adrenal cortex, in growth hormone and prolactin secreted by the pituitary gland, and in the natural opiates beta endorphin and enkephalin released in the brain (p. 12). And in fact, a number of these hormones have been shown to influence cardiovascular disease (Koertge, et al. 2002; Miller, 2002; Schiffrin, 2001).

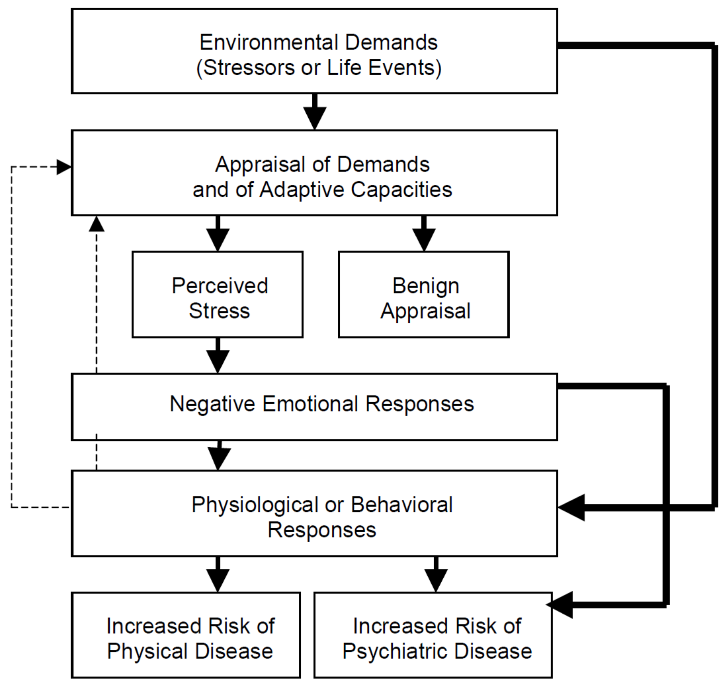


Figure 1. A model of the stress process designed to illustrate the potential integration of the environmental, psychological, and biological approaches to stress measurement. From Cohen, Kessler, and Gordon (1997).

Recent discoveries have led scholars to appreciate that *any chronic imbalance* of the autonomic nervous system presents a potent risk factor for adverse cardiovascular events, including early death. The most recent findings in the area support and extend this concept by showing that "any activity that chronically activates the sympathetic nervous system and-or diminishes parasym-pathetic activity, will increase the risk of cardiovascular events. In contrast, therapies that tip the autonomic balance toward parasympathetic dominance and decrease sympathetic tone will improve prognosis" (Curtis & O'Keefe, 2002).

Nature and Stress Reduction

What evidence exists that contact with nature might reduce autonomic activity and the psychological feelings associated with stress?

One line of studies concerning the relationship between contact with nature and lower levels of stress comes from reports of individuals feeling calm or being able to function more effectively after being in or viewing a green space. In one such study, individuals exposed to urban forests reported feelings of "peacefulness," "tranquility," and "relaxation" (Ulrich, 1993). Another study showed that individuals who had participated in a nature vacation reported decreased levels of occupational stress after the vacation (Mcdonald, 1996).

Similarly, in a study of patients about to undergo dental surgery, views of an aquarium with fish reduced anxiety and discomfort, and increased scores for patient compliance during surgery (Ulrich, 1992). A more recent study demonstrated a connection between visiting an urban green space and levels of stress: the more often the visits, the fewer reported illnesses related to stress (Grahn & Stigsdotter, 2003).

For children, exposure to green spaces has been shown to moderate the impact of stressful life events. In a study of 337 rural children, the impact of life stress was lower among children with high levels of nearby nature than among those with little nearby nature (Wells & Evans, 2003).

Another line of studies concerning the relationship between contact with nature and lower levels of stress comes from clinical tests of *physiological functioning*. For instance, 120 individuals watched a stressful film and then were shown videos of either urban or natural settings. Individuals who watched the nature settings showed significantly faster physiological recovery from stress than individuals who were assigned to watch the urban scenes (Ulrich, 1991). In a similar study, 160 individuals viewed one of four different video-taped simulated drives through outdoor environments immediately following and preceding mildly stressful events. Participants who viewed drives that showed very little vegetation, relative to participants who viewed nature-dominated drives, showed greater autonomic activity indicative of stress. In addition, participants who viewed nature-dominated drives experienced quicker recovery from stress and greater immunization to subsequent stress than participants who viewed drives that showed very little vegetation.

Similar findings have resulted from studies of workers exposed to indoor plants (Lohr, 1996), workers in rooms with views that varied by level of naturalness outside the window (Chang & Chen, 2005).

In sum, although there is considerable anecdotal and empirical evidence that contact with the urban forest reduces stress, there are only a handful of studies that provide clinical evidence of such an effect. The weakness in each of these studies is that the canopy cover – or degree of concentration – of the urban forest was not explored with the kind of detail that provides practitioners or designers enough information about how much urban forest to provide. The purpose of the study proposed here is to address this short-coming.

Thus, although previous work provides convincing evidence that contact with urban forests can impact autonomic functioning, *we have very limited evidence regarding the shape of the dose-response curve*. For example, the work of Ulrich, et al., (1991) and Parsons, et al., (1998) showed very clearly that simulations of nature impact electrodermal activity indicative of stress, but stopped short of identifying the concentration of nature necessary to reduce autonomic activity. The research proposed here will close this gap in our understanding.

Does exposure to nature guard against early death?

We believe that, for urban dwellers, regular contact with urban forests will result in lower levels of autonomic activity indicative of stress. Although we do not know how much exposure is necessary to have an impact on longevity, two recent studies suggest that the impacts – both in terms of health and in terms of economics -- may be enormous.

The first hint that living near an urban green space (as opposed to living in a less green urban area) may result in an increase in longevity came from a study of elderly people in Tokyo. That study found that living in areas with walkable green spaces was positively associated with longevity of Tokyo's senior citizens independent of their age, sex, marital status, baseline functional status, and socioeconomic status (Takano, Nakamura, & Watanabe, 2002).

The second hint came from a study of all residents of England between the years 2001 to 2005. Mitchell & Popham (2008) classified the population of England at younger than retirement age (n = 40,813,236) into groups on the basis of income and exposure to green space. They obtained individual mortality records (n = 366,348) and established that an association between income and mortality varied by exposure to green space. Mitchell and Popham report that all-cause mortality, and mortality from circulatory diseases, were lower in populations living in the greenest areas. The effects were particularly impressive for individuals in the middle and low-income categories (please see Figure 2).

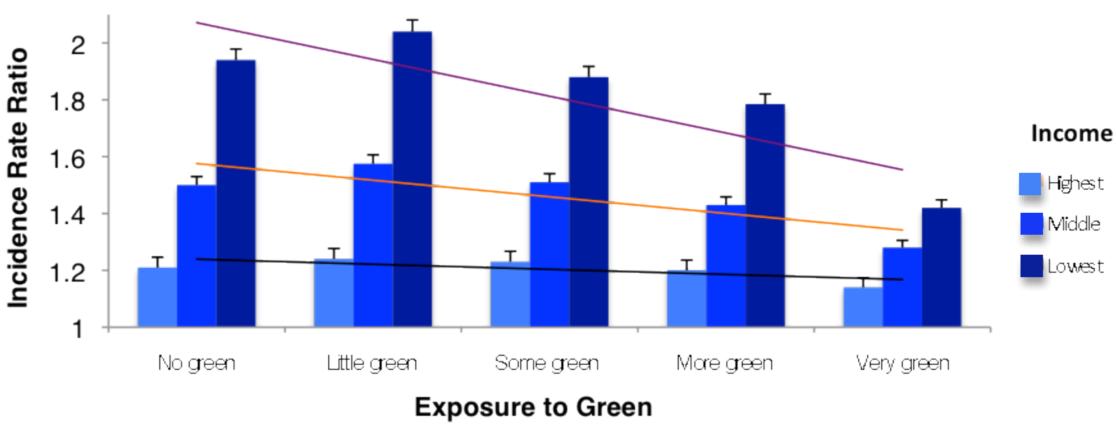


Figure 2. In the Mitchell and Popham study, the Incidence Rate Ratio, that is, the likelihood of dying during the study, was negatively associated with exposure to green spaces near the homes of people in the middle and low-income groups. For these two groups, greater exposure to urban forest was associated with lower likelihood of death.

Finally, in another study from 2008, Hu and his colleagues found that, in northwest Florida, neighborhood greenness and household income were negatively related to the incidence of mortality from stroke (Hu, Liebens, & Rao, 2008).

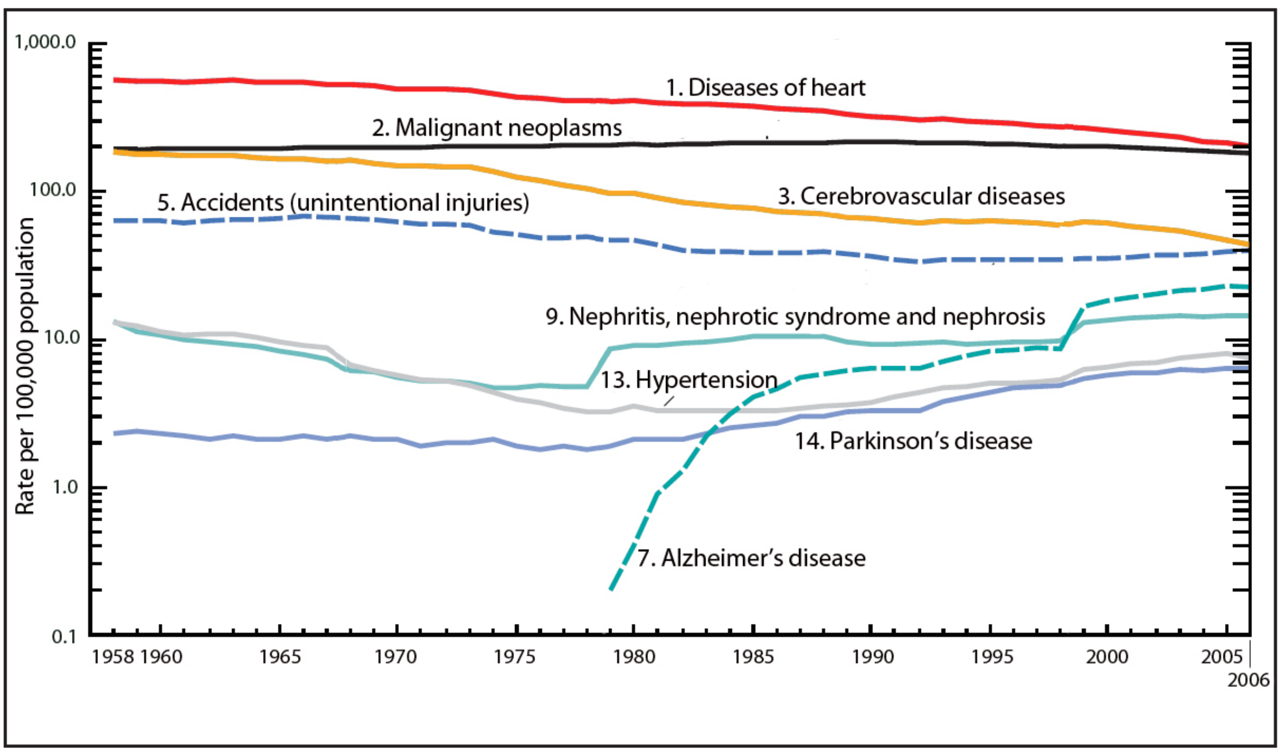
Thus, there are growing hints suggesting that exposure to urban forests reduce the level of stress that individuals feel and that over the years, these lower levels of stress result in longer, healthier lives. Wouldn't it be great if we could translate these hints into solid evidence that identifies the amount of urban forest necessary to produce lower levels of physiological stress in humans? The study proposed here seeks to do exactly that.

The number one and number three killers of Americans

An individual's capacity to moderate the demands and pressures of everyday life has profound and far-reaching consequences for their health and well-being. Chronic autonomic responses to stressful events can lead to long-term physiological dysfunction, resulting in increased risk for cardiac disease (Curtis & O'Keefe, 2002; Leenen, 1999), and stroke (Brook & Julius, 2000; Julius, 1998; Julius & Valentini, 1998).

As can be seen in Figure 1 below, cardiac disease and stroke are the number one and number three killers of Americans (CDC 2009). Cardiac disease accounts for 26% of all deaths in the United States. Stroke accounts for nearly 6% of the deaths. According to the CDC, approximately 2,400 Americans died each day from cardiac disease – about one death every 37 seconds. The CDC also reports that 393 Americans lose their lives each day from stroke – about one death every three and a half minutes.

Figure 1. Age-adjusted death rates for selected leading causes of death: United States, 1958-2006



(CDC, 2009)

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APPENDIX C: Budget Narrative for A Dose of Nature

Object Class Categories	Description of Budget Item	USFS	Illinois	Total
a. Personnel	**Principal Investigator** This represents 25% of the annual salary for Dr. Sullivan for year 1 and 2 with a 3% salary increase in year 2. It also includes a match of 1.25 months of summer salary for years 1 and 2.		$84,923	$ 84,923
	Post-Doctoral Scientist This represents a 50% - time Post-Doctoral Scientist for two years with a 3% salary increase in year 2.	$52,780		$52,780
	Graduate Students **PhD 50%, 12-month appointment for two years**. Annual rate starting out at $19,760 with 3% annual increases.	$40,113		$40,113
	MLA Student 25% for 9 months 9 months @ $791 per month = $7,119.	$7,119		$7,119
	Hourly Students 12 hours per week x 46 weeks per year @ $14 per hour = $7,728 per year	$15,456		$15,456
	Total Personnel Costs	**$115,468**	**$84,923**	**$200,391**
b. Fringe Benefits	**PI Sullivan:** Fringe benefits are 35.59%		$30,224	$30,224
	Post-Doc: Fringe benefits are 35.59%	$18,784		$18,784
	Graduate Students: Fringe benefits are 6.36%	$3,004		$3,852
	Hourly Students: Fringe benefits are 0.14%	$22		$22
	Total Fringe Benefit Costs	**$21,810**	**$30,224**	**$52,034**

Object Class Categories	Description of Budget Item	USFS	Illinois	Davey	Total
c. Travel	**Gathering site data, create videos, partner mtgs** **Conference Presentation**	$6,825 $6,500			$6,825 $6,500
	Total Travel Costs	**$13,325**			**$13,325**
d. Materials & Supplies	**Supplies for drawing and presentations**	$2,000	$2,000		$4,000
	3-D video camera (1 at $1,400 each) and **3-D glasses** (4 at $161 each)	$2,044			$2,044
	3-D TV with cables (two at $1,400 each)	$2,810			$2,820
	Paper and printing	$200			$200
	Printing for brochures reporting findings	$3,500			$3,500
	Blu-ray disc player for 3-D video (2 at $399 each)	$798			$798
	Salivette Cortisol testing (12 at $125 each)	$1,500			$1500
	Costs of Analysis of salivary samples (1170 at $15 each)	$17,550			$17,550
	ProComp5 Infinity (2 at $2,995 each)	$5,990			$5,990
	physiology suite software (2 at $275 each)	$275			$275
	Myoscan EMG sensor (2 at $275 each)	$550			$550
	HR/BVP sensor (2 at $275 each)	$550			$550
	Skin conductance sensor (2 at $275 each)	$550			$550
	Respiration sensor (2 at $275 each)	$550			$550
	EEG-Z™ Sensor (2 at $385 each)	$770			$770
	EKG Sensor (2 at $275 each)	$550			$550
	EMG Extender Cables (2 at $25 each) **and EMG Headband** (2 at $25 each)	$100			$100
	EKG Wrist Straps (2 at $60 each)	$120			$120
	Two terrabite Data storage (2 at $250 each)	$500			$500
	32 GB SD Disk for video storage (3 at $165 each)	$492			$492
	Total Materials & Supplies	**$41,409**	**$2,000**		**$43,409**
e. Other Costs	**Participant renumeration** (300 participants x $20)	$ 6,000			$6,000
	Tuition Remission Tuition recovery rate is 56.00%.	$26,450			$26,450
	Total Other Costs	**$32,450**			**$32,450**

Object Class Categories	Description of Budget Item	USFS	Illinois	Davey	Total
f. Subaward Costs (Davey)	**Personnel** Integration and framework design: 40 hours @ 50% discount rate of $60/hour = $2,400 Documentation and manuscript: 40 hours I-Tree Eco reporting features; Index by land-use and citywide: 60 hours I-Tree Streets reporting features; Index by land-use, management zone and citywide: 60 hours 50% discount rate of $60/hour for all hours	$12,000		$12,000	$24,000
	Travel Out-of-state trips : One development meeting for one persons @ $1,500/trip = $1,500	$750		$750	$1,500
	Distribution Develop, brand and integrate Human Health Index as part of user's manual, training curriculum, website content, online accessibility, and support framework for dissemination through I-Tree.	$1,800		$1,800	$3,600
	Total Subaward Costs	**$14,550**		**$14,550**	**$29,100**
h. Total Direct Costs	**The sum of all the direct cost categories**	**$239,012**	**$117,147**		**$356,159**
g. Indirect Costs	**USFS rate of 20%** Based on indirect cost rate of 20% to all direct cost categories except tuition remission. Total Direct Charges (except Tuition Remission)	$42,512			$42,512
	University of Illinois rate of 58.5% The University of Illinois applies an indirect cost rate of 58.5% to all direct categories except tuition remission. The University will apply the amount of indirect cost foregone (58.5% - 20%= 38.5%) from the USFS toward matching dollars.		$68,531 $81,836		$68,531 $81,836
	Total Indirect Costs	**$42,512**	**$150,367**		**$192,880**
h. Totals	**Total direct and indirect costs**	**$281,524**	**$267,515**	**$14,550**	**$563,589**