Enclosure 2

Special Technology Development Program
New Project Proposal

Complete a copy of this form for: 1) each new project proposal, and 2) each resubmitted but previously unfunded project proposal. Add lines within the form as necessary.

PROJECT NUMBER (Region-year-sequential number/priority)**:** R2-2001-01

PROJECT TITLE: The role of wildland fire and subsequent insect attack on ponderosa pine mortality

PROJECT STATUS (select one by deleting inapplicable option)**: New**

EXPECTED PROJECT DURATION (total years for project including current fiscal year)**: 3**

EXPECTED COMPLETION DATE OF THE PROJECT (fiscal year)**:**

SUBJECT: (mark all that apply using 1 for primary category and 2 for secondary categories): Biological Control___ Invasive Species___ Methyl Bromide Alternatives___ Models__1_ Monitoring__1_ Organism Biology___ Pesticides: Microbial ___ Pesticides: Synthetic___ PTIPS___ Population___ Risk and Hazard_2_ Remote Sensing___ Semiochemicals___ Silvicultural Technology_2__ Social Values__2_ Spray Technology___ Other_____

STATUS OF SUBJECT SPECIES (select one by deleting inapplicable options)**:** native

PROJECT OBJECTIVES (question to be answered by the project)**:**

1. Quantify cumulative impacts of insects and fire on post-fire recovery of ponderosa pine ecosystems.
2. Determine tree mortality across burned areas 1, 2, and 3 years post-fire.
3. Provide a system for determining which trees will die based on percent crown scorch, scorch height on the bole and percent of basal circumference scorch.
4. Develop a probability model for risk rating trees likely to be infested with insects based on percent scorch.
5. Develop a visual guideline for forest land managers to evaluate potential tree mortality.
6. Quantify the movement of insects from fire-damaged trees to uninjured trees.

BRIEF DESCRIPTION OF PROJECT: Describe primary activities for each year. This may be a clearly worded bulleted list or graphic of milestone activities.

- **Year 1 (FY 2001)**
  - Install transects and plots across fire areas.
  - Data collection from transects and plots.
- **Year 2 (FY 2002)**
  - Re-evaluate transects and plots to determine additional mortality and causes of mortality.
  - Monitor for movement of insects from fire-injured trees to uninjured trees
- **Year 3 (FY2003)**
  - Re-evaluate transects and plots to determine additional mortality and causes of mortality.
  - Data analysis and model development
  - Preparation of photographic guide book for land managers that predicts which trees are likely to die from wildland fire and those that are likely to die within 2 years from subsequent insect attack.
  - Manuscript preparation & presentation of results to targeted audience

FHP LEAD CONTACT (FHP person submitting proposal)**:**

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PRINCIPAL INVESTIGATOR(S) (add lines as necessary)**:**

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COOPERATORS (contributing to, but not leading, the project) (add lines as necessary)**:**

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
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Linda Wadleigh	R-3, Fire Management	Phone: (520) 635-8351 E-mail: lwadleigh@fs.fed.us Fax: (520) 635-8208

COOPERATOR INVOLVEMENT (add lines as necessary)**:**

Name	Role	Time Commitment
Black Hills NF	Study site location, GIS support, aerial photography, logistical support	2 weeks per year
Arapaho/Roosevelt NF	Study site location, GIS support, aerial photography, logistical support	2 weeks per year
Custer NF	Study site location, GIS support, aerial photography, logistical support	2 weeks per year
Coconino/Kaibab NF	Study site location, GIS support, aerial photography, logistical support	2 weeks per year

JUSTIFICATION (How does the project strengthen FHP program delivery/capability? What is the potential advantage over existing technology?)**:**

This project will define the impact caused by insects when interacting with another disturbance agent, wildfire. This will allow FHP to more accurately assist land managers in predicting potential tree mortality in post-fire situations. Currently, there is little information regarding fire/insect impact in ponderosa pine ecosystems. For example, there are no written or visual guidelines for field personnel to determine what tree will live or die in the near-term future in relation to the amount of damage caused by fire or the probability of injured trees being killed by insects. Furthermore, the probability of fire-damaged trees providing the source of an insect outbreak that subsequently spreads to uninjured trees remains unknown. The proposed project will address this lack of adequate information by formulating models and creating visual guides and, therefore, permit land managers to make more informed decisions regarding salvaging and insect control. This information will also be useful in the development of prescriptions for prescribed burning.

URGENCY (Does the project address a crisis situation? Would delay result in irreversible loss?)**:**

This project addresses an extremely critical situation. The year 2000 has been one of the worst wildland fire years in recorded history. Over the next few years, land managers across the West will be forced to make decisions on how to best tackle post-fire recovery, including determining both short-term and long-term tree mortality related to the fires and insects. Insect/fire interactions and how they will affect these decisions are not well understood in ponderosa pine ecosystems. A delay in beginning this project would result in a lost opportunity to provide land managers answers to these critical decision making processes.

Land managers are also being asked to dramatically increase their treatment of hazardous fuels to address the "over-accumulation of vegetation" as described in the draft Cohesive Strategy (Laverty and Williams 2000). Treatments will include mechanical methods and prescribed fire where deemed appropriate. Managers need to be able to weigh the use of prescribed fire and knowing its potential impact on overstory vegetation is an important component of that decision.

NATIONAL FHP TECHNOLOGY DEVELOPMENT PRIORITY (check one):

Priority 1: __ Priority 2: __ Priority 3: _X_ Priority 4: __

TECHNICAL COMMITTEE DEVELOPMENT PRIORITY (check one):

Priority 1: __ Priority 2: __ Priority 3: __ Priority 4: _X_

Priority 5: __ Priority 6: __ Priority 7: __ Priority 8: __

The proposed project directly addresses national FHP technology development priority 3 by developing techniques that land managers can use to quantify the impact of fire-insect interactions. In addition, the project would have implications to priority 2 by enabling land managers to integrate the impact of insects into silvicultural procedures and writing of prescriptions for prescribed fires. Moreover, while the project addresses technical committee development priority 4, the project will also develop visual tools to predict the outcome of insects at the stand level (committee development priority 6).

SCOPE OF APPLICATION (How widely are results likely to be applied—geographic area, range of pests, length of time?)**:**

This project will provide information that will potentially assist managers across the range of ponderosa pine throughout the West. In addition, this information may provide insights into fire-insect functions in other cover types. The range of pests analyzed will include primary (Scolytidae bark beetles) and secondary (Cerambycidae, Buprestidae wood boring beetles) insects. The scope of this project should have application for current and future wildland fire in ponderosa pine ecosystems.

The draft Cohesive Strategy discusses concentrating most treatment efforts in short return-interval fire-adapted ecosystems in the Western Regions. The Strategy also targets those sites defined as Condition Class 2 and 3, areas at moderate to high risk for damage to ecosystem components from wildland fire due to the number of missed fire cycles. The majority of the ponderosa pine type falls within this fire regime of frequent, low intensity fires, and is well represented in Condition Class 2 and 3.

RESEARCH BASIS (strength of research basis, including publication citations)**:**

Survival of ponderosa pine following wildfire events depends on a number of factors, including level of injury to the tree and environmental conditions following the fire. One of the main post-fire environmental factors is insect activity. Mountain pine beetle (*Dendroctonus ponderosae*), the primary tree-killing insect of ponderosa pine, does not typically infest fire-damaged trees; however, there is a host of secondary insects that are attracted to and kill fire-damaged trees (Rasmussen et al. 1996). These secondary insects include *Ips* spp., red turpentine beetle (*Dendroctonus valens*), and wood boring insects. The question to be addressed is how much post-fire tree mortality can be attributed to insects.

Previous work has documented the substantial impact that post-fire, insect-caused mortality can have on forest conditions (Miller and Keen 1960, Ryan and Amman 1996, Rasmussen et al. 1996). It is also understood that as fire injury increases, the probability of tree mortality increases (Miller and Keen 1960, Ryan and Reinhardt 1988). Work from northwestern Wyoming describes the amount of post-fire mortality in lodgepole pine, Douglas-fir, and spruce/fir forest types following the Yellowstone fires of 1988. Data gathered from the Yellowstone fires indicate that Douglas-fir and lodgepole pine with 59% and 56%, respectively, of their base girdled by fire survived into the following year (Ryan and Amman 1996). Of the post-fire tree mortality, 13% of Douglas-fir, 18% of lodgepole pine and 7% of spruce and fir were determined to be killed by insects (Ryan and Amman 1996). However, there is a paucity of information and a need to document the post-fire mortality in similar situations in ponderosa pine forests (Fischer 1980). Miller and Keen (1960) observed that western pine beetle-caused mortality of ponderosa pine varied by the percentage of fire-induced defoliation. Less than 15% of trees were killed by the beetle when trees were defoliated less than 50%, while up to 87% of the trees were beetle-killed when there was greater than 50% defoliation. These examples illustrate that tree survival can be reduced by insect activity and original mosaics of green and dead trees apparent immediately following wildland fires can be altered.

The studies on bark beetle activity and delayed tree mortality following Yellowstone fires also found a trend of increasing insect infestations with time. The high level of insect infestation over time suggests that insect populations increased in fire-injured trees and then spread to uninjured trees (Ryan and Amman 1996). As mentioned previously, mountain pine beetle does not seem to be attracted to fire-injured trees (Ryan and Amman 1996, Rasmussen et al. 1996) and therefore populations should not build up in scorched ponderosa pine. However, *Ips* species, red turpentine beetle and perhaps western pine beetle have the potential to increase in burn areas and subsequently attack uninjured trees.

Estimates of mortality for ponderosa pine damaged by fire are based largely on amount of crown scorch. Dieterich (1979) and Harrington (1987) both found that trees with up to 90% of their crowns scorched could survive. Other studies found mortality from scorching thresholds at 60% (Herman 1954), 67% (Davis et al. 1968), and 80% (Lynch 1959) of the live crown. Recovery from fire scorch depends on timing of fire and whether the degree of bole scorch was considered. Fires that occurred in the autumn and caused crown scorch were less likely to kill the trees than those that occurred during the active growing season in the spring or early summer (Dieterich 1979, Harrington 1987). The single most important variable that was measured in determining whether a tree would live or die was the percent of pre-fire live crown that was scorched (Wyant et al 1986, Dieterich 1979, Harrington 1987). In most cases, it was assumed that amount of cambial damage was related to the amount of crown scorch (Wyant et al 1986). However, there can be significant differences between crown scorch and cambial injury depending on fire intensity and whether fires occur primarily on the ground or in the crowns of trees. Based on a tour of the more than 80,000 acre Jasper Fire in the Black Hills National Forest, burn areas were characterized as complete crown and bole consumption, high intensity crown fires with minor damage to the boles of trees, high intensity ground fires with little crown scorch, or minor amounts of crown and bole scorch. The impact of fire and subsequent insect infestation will likely differ among these areas and guidelines are needed for these different situations.

The amount of tree mortality also depends on tree size. In general, smaller trees suffer greater levels of mortality than larger trees having the same degree of burn (Lynch 1959, Harrington 1987). Again, however, a discriminate analysis was not used to differentiate between the effects of fire in the crown compared with the bole among trees of different size classes. Tree size can also influence insect activity. Some bark beetle species are attracted to larger diameter trees and other species characteristically infest smaller diameter trees (Furniss and Carolin 1977).

METHODS (project design, hypothesis, statistical approach, and QA/QC procedures)**:**

Quantifying the cumulative impact of fire and insects on ponderosa pine ecosystems will adhere to methodology developed in previous studies on ponderosa pine ecosystems (Wyant et al. 1986, Harrington 1987) and other forest types (Rasmussen et al. 1996, Ryan and Amman 1996). However, methods will be expanded to cover a broader variation of factors affecting delayed tree mortality. The proposed methods should permit the development of a simple, easy to use visual guideline for land managers to assess what trees will live and what trees will die within three years following a wildland fire. Furthermore, the results of these methods would allow land managers to model cumulative impacts and make more informed decisions concerning the future management of forest landscapes.

Site locations

Extensive wildfires occurred across the western United States during the summer of 2000. Ponderosa pine forests burned in South Dakota, Nebraska, Montana, Wyoming, Arizona, New Mexico and Utah. Therefore, more than adequate areas exist to quantify the effects of fire and insects in these ecosystems and should provide sufficient variation in geophysical and regional growth factors influencing delayed tree mortality. We propose to examine the cumulative effects across this variation in the Black Hills National Forest of South Dakota and Wyoming (late summer burn), Custer National Forest in Montana (late summer burn), Arapaho-Roosevelt in Colorado (early season burn) and the Coconino and Kaibab National Forests in Arizona (early season burn). The extent of wildland fire has been mapped in these areas and GIS maps of soil, elevation, and other geophysical parameters exist. We have already contacted personnel in these national forests and have oral agreements to carry out the proposed work. These national forests have expressed the urgency of needing answers to the commonly asked what trees will live and what trees will die.

By including these four sites we will be able to compare the effect of fire season on tree mortality and subsequent insect activity. For a rigorous statistical comparison between fire season and site location, replication of both early season and late season fires would be needed at each location. While the current situation will only allow an observational comparison, the results of the proposed study would give a more thorough insight into the differential impacts of wildfires depending on season.

Individual tree measurements and plot establishment

We propose to measure a sufficient number of individual trees and to establish plots to statistically analyze the cumulative effects of fire and insects on delayed tree mortality across patchy and variable landscapes. In addition, enough trees will be included within these plots to analyze variation in tree size, and the amount of crown and basal circumference scorch. Trees that have 100% defoliation caused by the fire will certainly die and trees escaping injury to the crown and bole will probably live. However, in between these extremes there exists much uncertainty. By repeatedly measuring the variables listed below, we will be able provide a more accurate prediction of what lives and what dies.

Measurement of variables on individual trees will be conducted along transects across the burned areas. All trees greater than 2.0 inches dbh that intersect the transect line will be measured for the variables listed below. These transects will be stratified across areas of varying tree size and fire severity to obtain the minimum sample sizes for a given size and scorch intensity category. In addition, fixed radius plots will be established along the transects to characterize the site and stand conditions prior to fire. An equal number of samples on unburned trees also will be established to provide an estimate of tree mortality without fire.

At the time of transect and plot establishment, individual tree and plot measurements will include:

<u>Individual tree measurements</u>

1. Tree height
2. Tree diameter at breast height
3. Total crown height
4. The percentage of live crown that was scorched
5. The percentage of live crown that was consumed
6. The percentage of basal circumference that was scorched
7. Scorch height on the bole

Site and stand measurements

1. Stand density based on trees per acre, stand density index, basal area
2. Plot aspect and slope percent
3. Soil type
4. Depth of fire into soil

Trees will be categorized according to the percentage of crown scorch and consumption (unburned, 1-33%, 34-66%, 67-89%, 90+ %) (Harrington 1987), and basal circumference scorch (unburned, 1-20%, 21-40%, 41-60%, 61-80%, 81-100%) (Ryan and Amman 1996). In addition, tree size will be grouped according to: 2.0-3.9 inches at dbh, 4.0-6.9 in., 7.0-10.9 in., and greater than 10.9 in. (Harrington 1987). Although an actual estimate of the each variable will be recorded and used for logistic regression analysis, these categories will be used for developing visual guidelines.

Trees in each transect will be marked with a numbered, metal tag to permit re-evaluation over the lifetime of the study. Plot location will be recorded with a handheld GPS device. Tree and plot measurements will be repeated over the three years of the proposed study. Measurements will be recorded at the beginning, middle and completion of each growing season. This will allow both within and between season analyses of effects.

Quantifying insect infestation of fire-injured trees and spread of insects to uninjured trees
Insects attacking trees will be classified as primary (those that can infest and kill healthy trees) or secondary bark beetles (those commonly attracted to weakened or recently killed trees), wood borers (Buprestidae or Cerambycidae) or other insects (Rasmussen et al. 1996, Ryan and Amman 1996). Insect attack will be detected by inspecting the lower bole for boring dust and for insect entrance and exit holes. Following detection of tree mortality based on the presence or absence of living foliage, insect species will be identified by removing portions of bark, exposing the phloem and cambium (Ryan and Amman 1996).

Monitoring for the potential spread of insects from fire-damaged trees to uninjured trees will be accomplished through control trees and aerial surveys. Ground surveys will be traversed through stands neighboring transects that contain primarily uninjured trees. Aerial surveys are conducted by FHP at the end of each summer and provide a method of detecting developing insect outbreaks.

Visual guideline development
Based on the data gathered from the repeated measurement of plots, we will develop pictorial guidelines and associated text that will allow ground crews to easily and quickly estimate whether a tree will die or live. Photographs of individual trees and plots will be taken at the time of transect and plot establishment to capture the range in variation in crown and bole scorch and that portray threshold levels of tree mortality related to tree injury.

Model development
In addition to the development of visual guidelines, the project will gather data to create a logistic regression model relating variation in tree injury to tree mortality caused by either fire or insects. The model would have the potential to be incorporated into existing software for vegetation (Forest Vegetation Simulator) and fire (Fire and Fuels Extension, BEHAVE) management.

MEASURES OF SUCCESS:

Standard of Success: Success will be measured when land managers use results from the study in making decisions regarding post-fire recovery.

Expected Outcomes: Outcomes will be models that can be used to more accurately predict impacts after wildfire occurs in ponderosa pine forests. These models can then be used when making decisions regarding post-fire recovery efforts. Moreover, the development of a simple to use visual guide will aide field personnel in marking trees or areas for salvage and insect control.

Mortality estimates can also be used to assess the impact of prescribed fire by helping the manager determine acceptable fire behavior limits compared to predicted scorch from fire behavior models such as BEHAVE.

Implementation of Products/methods: Products will be implemented by field crews who are involved in marking fire-damaged areas for salvage and will be used by planners in NEPA documents when deciding what actions to take following wildland fires. Products will also be used in writing prescriptions for prescribed fire and in NEPA documents addressing the type of treatment to use.

PRODUCTS AND DUE DATES:

Guidelines for land managers in determining post-fire impacts caused by fire/insect interaction. Final guidelines will be completed by December of 2003.

PUBLICATIONS (how results will be reported)**:**

Information will be published as technical reports and peer-reviewed journal articles.

TECHNOLOGY TRANSFER (How will products or methods be transferred to users, adapted to other uses, or sustained by continuing technology transfer?)**:**

Technical reports and articles will be presented to land managers with details on field use and incorporation into NEPA planning documents.

Slide presentation to national forest staff, conferences and other appropriate meetings.

LONG-TERM BUDGET REQUEST: (estimates by fiscal year and funding, both monetary and in-kind, excluding FHP base funding) (extend table as necessary)**:**

	Item	Requested FHP STDP Funding	Other-Source Funding	Source
FIRST YEAR				
Administration	Salary	21,000.00	12,000.00	RMRS, NF's, Region 3 RO
	Overhead			
	Travel	7,000.00	4,000.00	RMRS
Procurements	Contracting			
	Equipment	2,000.00		
	Supplies	2,000.00		
Year Totals		32,000.00	16,000.00	

SECOND YEAR				
Administration	Salary	20,000.00	12,000.00	RMRS, NF's, Region 3 RO
	Overhead			
	Travel	7,000.00	4,000.00	RMRS
Procurements	Contracting			
	Equipment	1,000.00		
	Supplies	1,000.00		
Year Totals		29,000.00	16,000.00	

THIRD YEAR				
Administration	Salary	20,000.00	17,000.00	RMRS, NF's, Region 3 RO
	Overhead			
	Travel	7,000.00	4,000.00	RMRS
Procurements	Contracting			
	Equipment	1,000.00		
	Supplies	1,000.00		
Year Totals		29,000.00	21,000.00	
PROJECT TOTALS		90,000.00	53,000.00	

LITERATURE, CITATIONS, ATTACHMENTS, etc.:

Davis, J.R., P.F. Pfolliott and W.P. Clary. 1968. A fire prescription for consuming ponderosa pine duff. USDA For, Serv. Res. Note RM-115. 4 p.

Dieterich, J.H. 1979. Recovery potential of fire-damaged southwestern ponderosa pine. USDA For. Serv. Note RM-379. 8 p.

Fischer, W.C. 1980. Prescribed fire and bark beetle attack in ponderosa pine forests. Fire Management Notes 41: 10-12.

Harrington, M.G. 1987. Ponderosa pine mortality from spring, summer, and fall crown scorching. Western Journal of Applied Forestry 2: 14-16.

Herman, M.E. 1954. A guide for marking fire-damaged ponderosa pine in the southwest. USDA For. Serv. Note RM-13. 4 p.

Laverty, L. and J. Williams. 2000. Protecting people and sustaining resources in fire-adapted ecosystems-a cohesive strategy. USDA For. Serv. Report. 80 pp.

Lynch, D.W. 1959. Effects of a wildfire on mortality and growth of young ponderosa pine trees. USDA For. Serv. Intermt. For. & Rang. Exp. Stn. Res. Note 66. 8 p.

Miller, J.M. and F.P. Keen. 1960. Biology and control of western pine beetle: a summary of the first fifty years of research. USDA For. Serv. Research Misc. Pub. 800.

Rasmussen, L.A., G.D. Amman, J.C. Vandygriff, R.D. Oakes, A.S. Munsen and K.E. Gibson. 1996. Bark beetle and wood borer infestation in the Greater Yellowstone Area during four postfire years. USDA For. Serv. Research Paper INT-RP-487. 10 p.

Ryan, K.C. and E.D. Reinhardt. 1988. Predicting postfire mortality of seven western conifers. Can. J. For. Res. 18: 1291-1297.

Ryan, K.C. and G.D. Amman. 1996. Bark beetle activity and delayed tree mortality in the Greater Yellowstone Area following the 1988 fires. Ecological Implications of Fire in Greater Yellowstone, 1996: 151-158.

Wyant, J.G., P.N. Omi and R.D. Laven. 1986. Fire induced tree mortality in a Colorado ponderosa pine/Douglas-fir stand. Forest Sci. 32: 49-59.

STDP PRODUCTION FUNCTION

PROJECT NUMBER: R2-2001-01

PROJECT COST:

Year	01	02	03
	$48,000.00	$45,000.00	$50,000.00

PROJECT OBJECTIVE (BRIEF DESCRIPTION OF THE PROJECT AND EXPECTED OUTCOME):
This project will help in defining the impact caused by insects when interacting with another disturbance agent, fire. This will allow FHP to more accurately assist forest land managers assess potential mortality in post-fire situations. Currently, there is little information regarding fire/insect impact in ponderosa pine ecosystems. This project will help answer some of those questions and allow land managers to make more informed decisions. Outcomes will include:

- Quantify cumulative impacts of insects on post fire recovery
- Determine mortality across burned areas 1,2, and 3 years post-fire
- Provide a system for determining which trees will die based on percent crown scorch, scorch height on the bole and percent of basal diameter scorch
- Develop a model for risk rating trees likely to be infested with insects based on percent scorch
- Develop a visual guideline for forest land managers to evaluate potential tree mortality

ASSUMPTIONS:

1. Guidelines from this project will lead to more accurate mortality estimates for post-fire recovery projects.

2. More accurate post-fire mortality estimates will decrease recovery costs. Trees that will not die can be left behind as a seed source reducing the need for planting. Assume that with the project the number of acres that need planted will be 10% less than without project.

3. This project will lead to more accurate assessments of standing dead vs. standing live trees for salvage sale valuation. Assume that without project all volume would fall under salvage harvest, with project 10% would be green harvest and 90% would be salvage harvest.

4. These calculations are based on data for the Black Hills National Forest. It is assumed that the benefit/cost ration would be even greater if calculated over the entire range of fire damaged ponderosa pine throughout the west.

5. Benefits will accrue over a 3-year period.

BACKGROUND DATA:

There are currently close to 100,000 acres affected by fire in the Black Hills. There are roughly 1,500,000 acres of ponderosa pine in the Black Hills that could be affected by fire/insect interactions.

Sanitation/salvage nets around $62.00 per acre as opposed to green tree harvest which is about $182.00 per acre. In the Black Hills, the average volume per acre is 4.5 MBF. About 2000 acres a year will be green tree harvest versus salvage harvest.

Tree planting costs are about $420.00 per acre. About 2000 acres a year would be planted for the next 5 years.

CALCULATIONS

EXPENDITURE & OUTPUT VALUES (EOV) WITHOUT PROJECT:

$0 in decreased planting costs and increased green tree vs. salvage revenue.

EXPENDITURE & OUTPUT VALUES (EOV) WITH PROJECT:
($120/acre for 2,000 acres for increased value of green vs salvage harvest difference) + ($420/acre x 2,000 acres less planting expense) = $240,000.00 + $840,000.00 = $1,080,000.00

Year	Benefit	Discounted Benefit
2001	$1,080,000.00	$1,080,000.00
2002	$1,080.000.00	$1,038,436.00
2003	$1,080,000.00	$ 998,524.00
Total Benefits=		$3,116,960.00

BENEFIT (CHANGE IN EOV) ATTRIBUTABLE TO PROJECT:
B = $(with) - $(without)

$3,116,960.00 - $0.00 = $3,116,960.00

BENEFIT/COST RATIO:
B/C = $(with) - $(w/o)
$(STDP cost) + $(treatment cost, where applicable)

$3,116,960.00/$143,000.00 = 22:1

BENEFIT ATTRIBUTABLE TO STDP:
Benefit attributable to STDP funds = $(STDP cost) x (B/C)

$143,000.00 x 22= $3,116,960.00

PNV OF PROJECT:
PNV of project = $(Benefit) - $(cost)

$3,116,960.00 - $143,000.00 = $2,973,960.00

PNV OF STDP:
PNV of project = $(Benefit attributable to STDP) - $(STDP cost)

$3,116,960.00 - $143,000.00 = $2,973,960.00