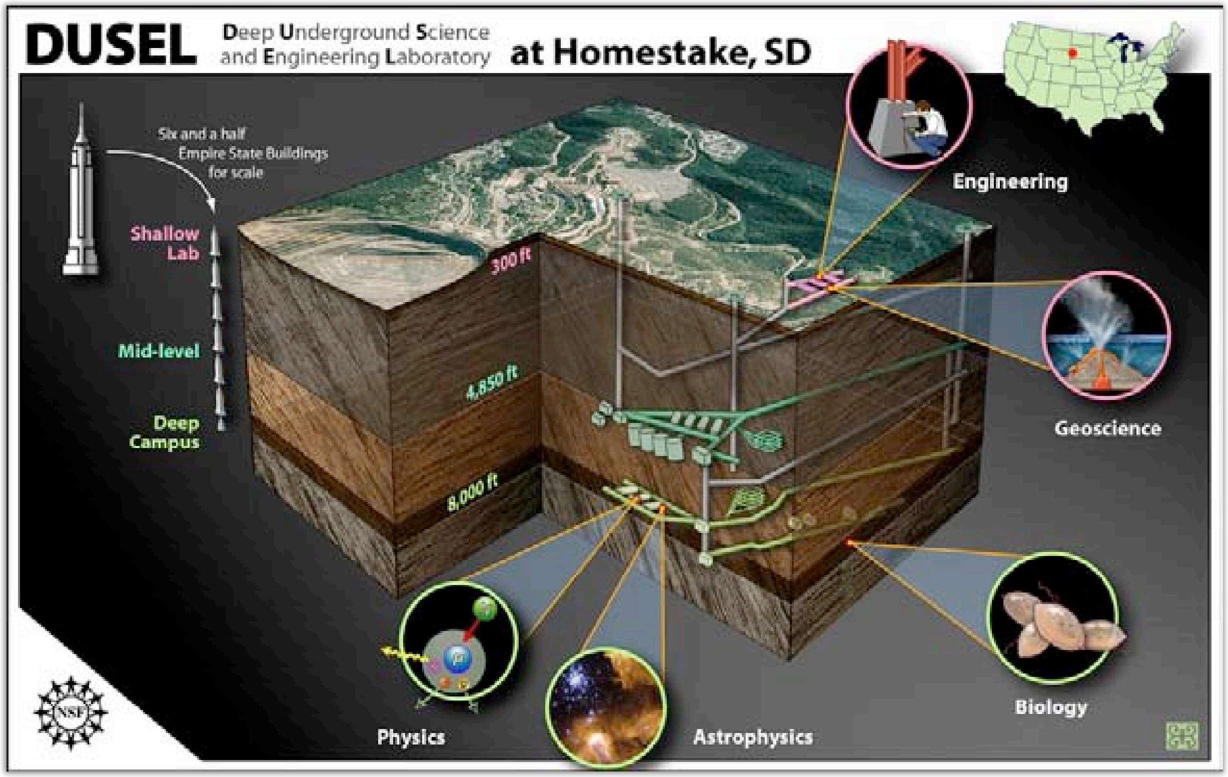
The Deep Underground Science and Engineering Laboratory at Homestake



Outline of this Presentation

- **Part 1** (pages 3 - 16)
- Deep Underground Science and Engineering Laboratory (DUSEL): What does it do? What are its Science Goals?
- **Part 2** (pages 17 - 57)
- Laboratory Criteria and Specification
- Homestake's Approach to Creating DUSEL
  - South Dakota's Sanford Lab
  - NSF's MREFC Process
- Project Process
- References, Personnel, Other Documentation

Nomenclature

- Sanford Lab - *noun* - surface to 4850L, mostly in the Davis Cavity ($65M State-run project)

- Sanford Lab hosts Early Implementation Program - 12 experiments in all disciplines between 2007 and 2011 (starting point for DUSEL construction)

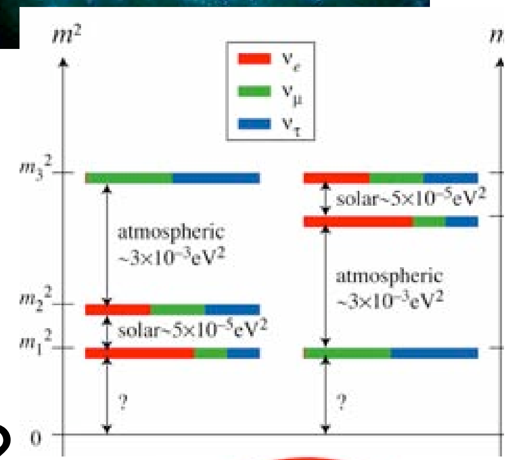
- DUSEL - *noun, verb* - NSF process to establish an MREFC and create a major new user facility ($500M total = $250M facility, $250M expts.)

DUSEL Science

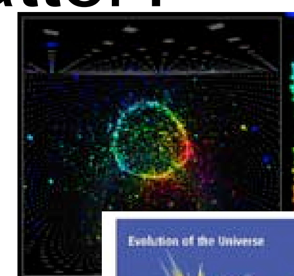
- DUSEL will be a multidisciplinary deep underground science user facility
  - **Physics**: rare searches, exquisite shielding from cosmic rays and other backgrounds
  - **Biology**: examination of the limits and evolution of life in the underground, interactions with geology and hydrology, search for new forms
  - **Earth Science**: geophysics, rock mechanics, geochemistry, hydrology, interactions among...
  - **Engineering**: how to excavate faster, better, safer, cheaper, larger, deeper, ...
  - **Education**: coupling public outreach to science

Deep Science Questions

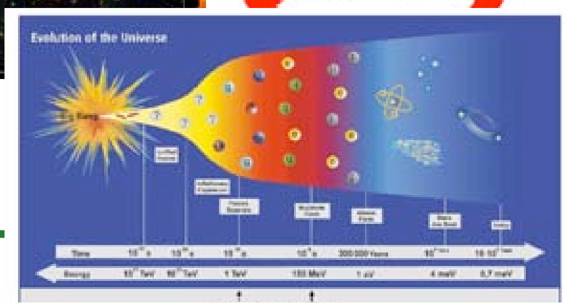
- What is the universe made of?



- What is dark matter?
- What are neutrinos telling us?
- What happened to the antimatter?



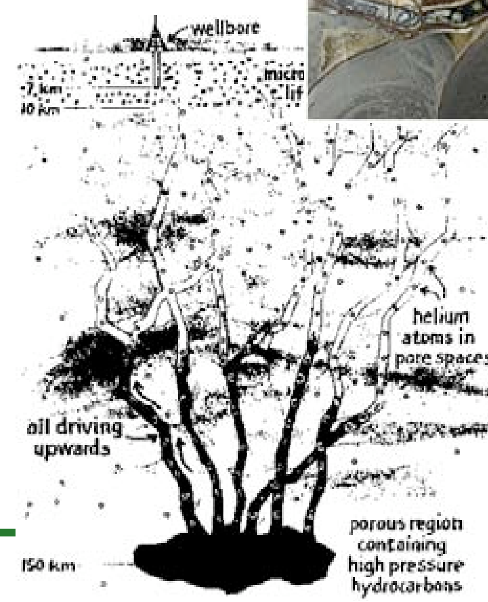
- Are protons unstable?
- How did the universe evolve?



from S-1 Deep Science

Deep Science Questions

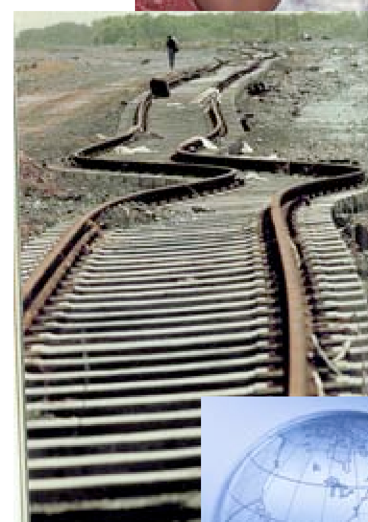
- How do biology and geology interact to shape the world underground?
- How does subsurface microbial life evolve in isolation?
- Did life on earth originate beneath the surface?
- Is there life underground as we don’t know it?



Deep Science Questions

- What are the interactions among subsurface processes?

- Are underground resources of drinking water safe and secure?
- Can we reliably predict and control earthquakes?



- Can we make the earth "transparent" and observe underground processes in action?

from S-1 Deep Science

Deep Science Questions

- What are the mechanical properties of rock?
- What lies between the boreholes?
- How does rock respond to human activity?
- How does water flow deep underground?
- How can technology lead to a safer underground?



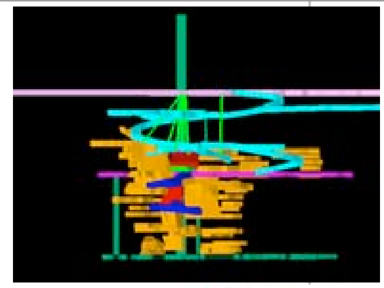

from S-1 Deep Science

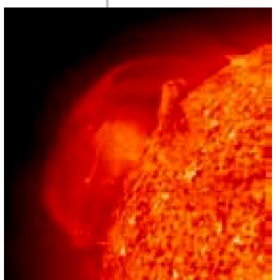
DUSEL: the Big Picture

Education & Public Outreach

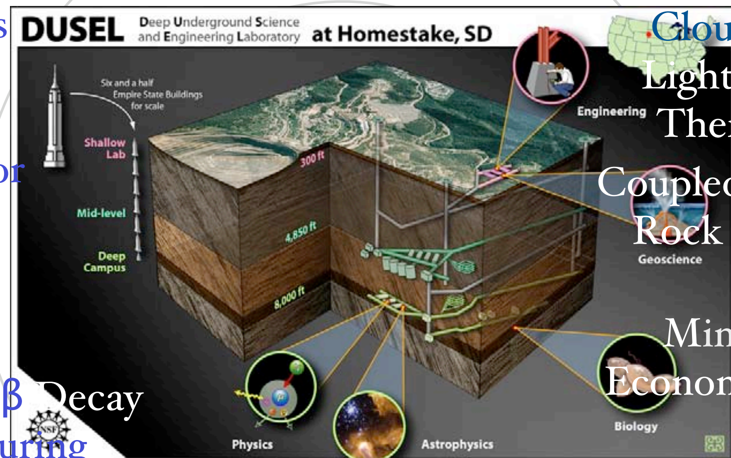
Dark Matter
Cosmology
Astrophysics
Neutron Oscillation

Geo-Database
Geo Modeling
Geophysics
Seismology
Fracture Study

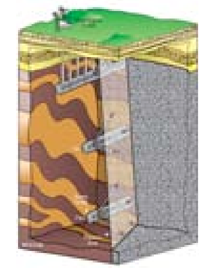


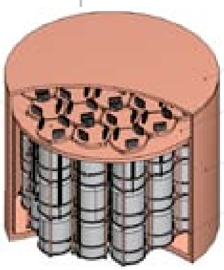


Solar Neutrinos
Geoneutrinos
Underground
Accelerator for
Astrophysics
Gravity Waves

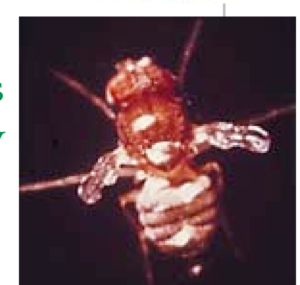


Cloud Formation
Lightning Physics
Thermal History
Coupled Processes
Rock Mechanics
Hydrology
Mineral Studies
Economic Geology

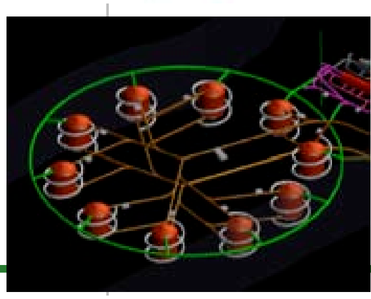




Neutrinoless ββ Decay
U/G Manufacturing
Low Background Counting



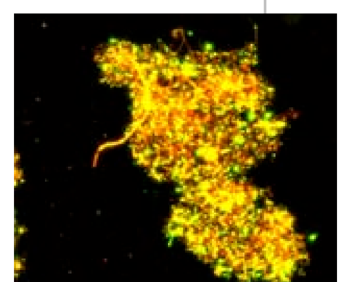
Geomicrobiology
Bioprospecting
Life at Extreme Conditions
Geochemistry
Ecology
Environmental Studies



Neutrino Properties
Long-baseline ν Oscillation
CP violation
MNSP Matrix
Nucleon Decay
Atmospheric Neutrinos

Underground Engineering

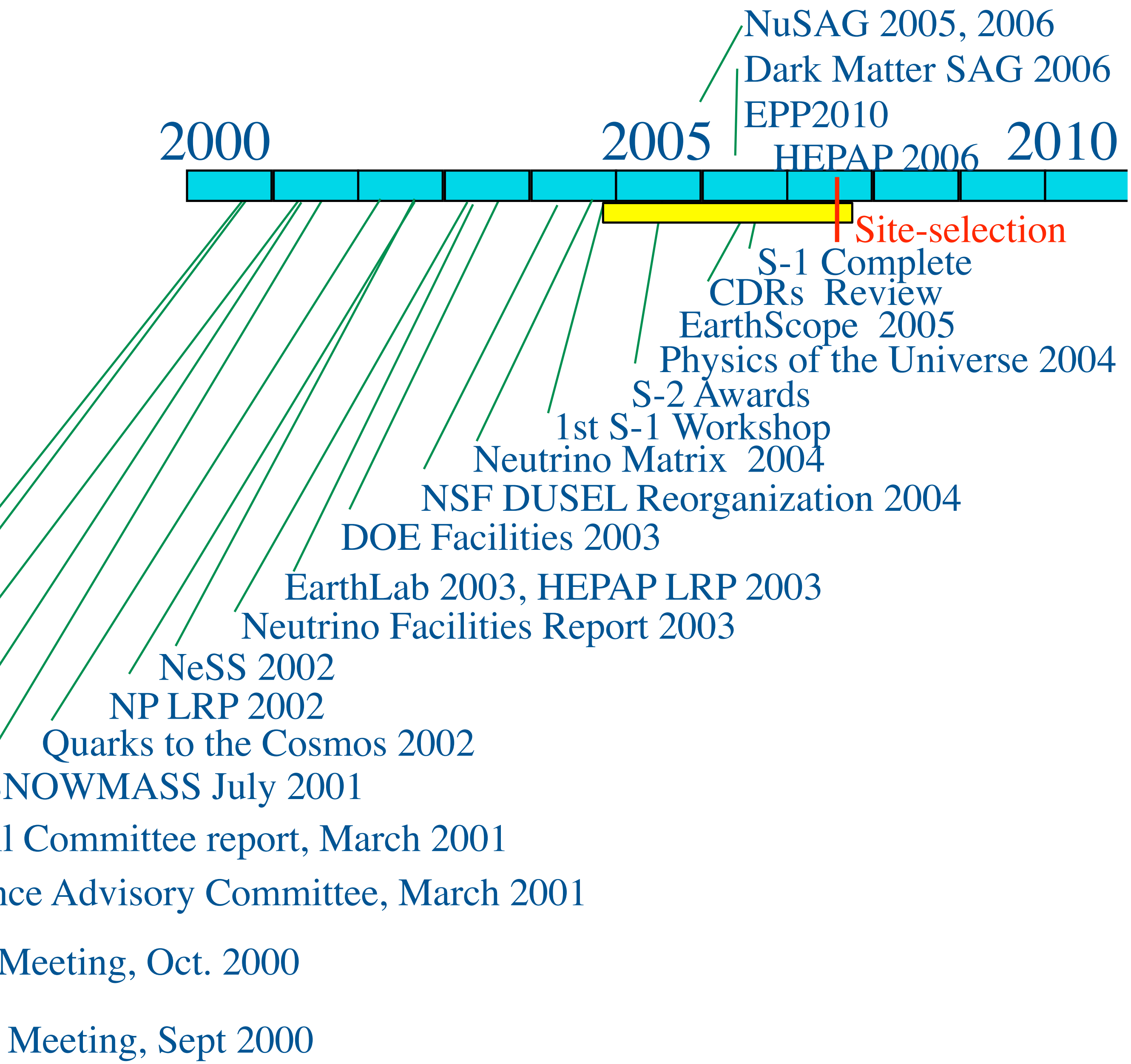
Homeland Security



Laboratory Criteria and Specification Inputs

- Bahcall/Lesko Committee 2001 and earlier proposals
- International Facilities (SNOLab, Gran Sasso, Kamioka, other URLs)
- National Academy Reports (principally Science oriented rather than Facility)
- DOE, Multi-agency, APS reports, LRPs,
- NSF's DUSEL Process

The Vetting of DUSEL



NSF Process to Create an Underground Laboratory

- 3-step DUSEL Process
  - S-1: site-independent science case
    - Sadoulet leading this effort
  - S-2: site dependent projection on different sites (Conceptual Design Report)
  - S-3: Technical Design solicitation competition
    - Funding in FY11 for DUSEL construction

DUSEL Progress

- **S-1 Led by** Bernard Sadoulet,UC Berkeley with Hamish Robertson, U.W.; Gene Beier, U. Penn; Charles Fairhurst, U. Minnesota;T.C. Onstott, Princeton; James Tiedje, Michigan State
  - Conducted extensive workshops, information gathering, discussions with the agencies, foreign laboratories, etc.
- **S-1** Report Released: www.dusel.org - Deep Science
- **S-2** 8 Candidate sites, 2 awards
  - **July 2006** Henderson and Homestake

DUSEL Progress

- **August 06** non-competitive review of the two CDRs
- **September 06** S-3 solicitation announced, funds to be provided to develop *Preliminary Design*, this Report will be the basis for case for DUSEL in subsequent reviews
- **Fall 06** NSF and DOE announce call for proposals for DUSEL R&D (Jointly reviewed between DOE and NSF)
- **9 January 07** Responses to S-3 Solicitation: 4 proposals

  Homestake, Henderson, Cascades, Soudan
- **9-13 March 07** Review of 4 proposals, starting with site visits

DUSEL Progress & Remaining Steps

- ☑ **19-22 April 07**, panel review of the four proposals
- ☑ **10 July 07** funding for a single proposal to develop advanced plans for DUSEL
  - Next step is to baseline plan: Preliminary Design to be prepare for review by NSF, MREFC Panel, NSB, ... Development of Final Design, 3 year effort
  - Homestake Collaboration Open, additional participation welcomed and encouraged
- ☑ **September 07** Cooperative Agreement completed
  - **Winter 07** Call for **Initial Suite Experiments** (iterative process) S-4 first step, Roll out meeting 2 - 4 November
  - **FY11 DUSEL funding**, include Experiments and Facility
    - Experiments > 50% of ~$500M MRE

S-1 Findings & Recommendations

www.dusel.org

- **Findings:**
- Deep underground science is an essential component of research at the frontier
  - Disciplines in transformation
- Benefits to society
  - Worldwide need for underground space
- Need for a U.S. world-class deep multidisciplinary facility
- **Recommendations:**
  - Strong support for deep underground science
- A cross agency Deep Science Initiative
  - A Deep Underground Science and Engineering Laboratory (6000 mwe, 3000 mwe, 30 to 50 years, ASAP)

from S-1 Deep Science

- Part 2

  Homestake Near and Far Term - Status and Planning

Letters of Interest: Homestake's own efforts to define an Experimental Program in Parallel with S-1

- Winter 2005-06 Issued an International Call for Letters of Interest
- Established a Program Advisory Committee
- ~85 LOI responses
  - 25% Physics
  - 10% Education and Public Outreach
  - 65% Earth Science, Biology, Engineering

Initial Suite of Experiments for Homestake DUSEL

- With the Letters of Interest and the Program Advisory Committee's Recommendations:
  - candidates for the Sanford Lab (early program) were identified (discussed below)
  - a strawman Initial Suite of Experiment was established factoring in depth requirements, approximate timelines, cavity requirements, and other laboratory criteria
- This strawman was then mapped into a conceptual facility layout, plan and schedule
- Good match to S-1 Science Goals

Homestake DUSEL Plans

300L R&D, E&O

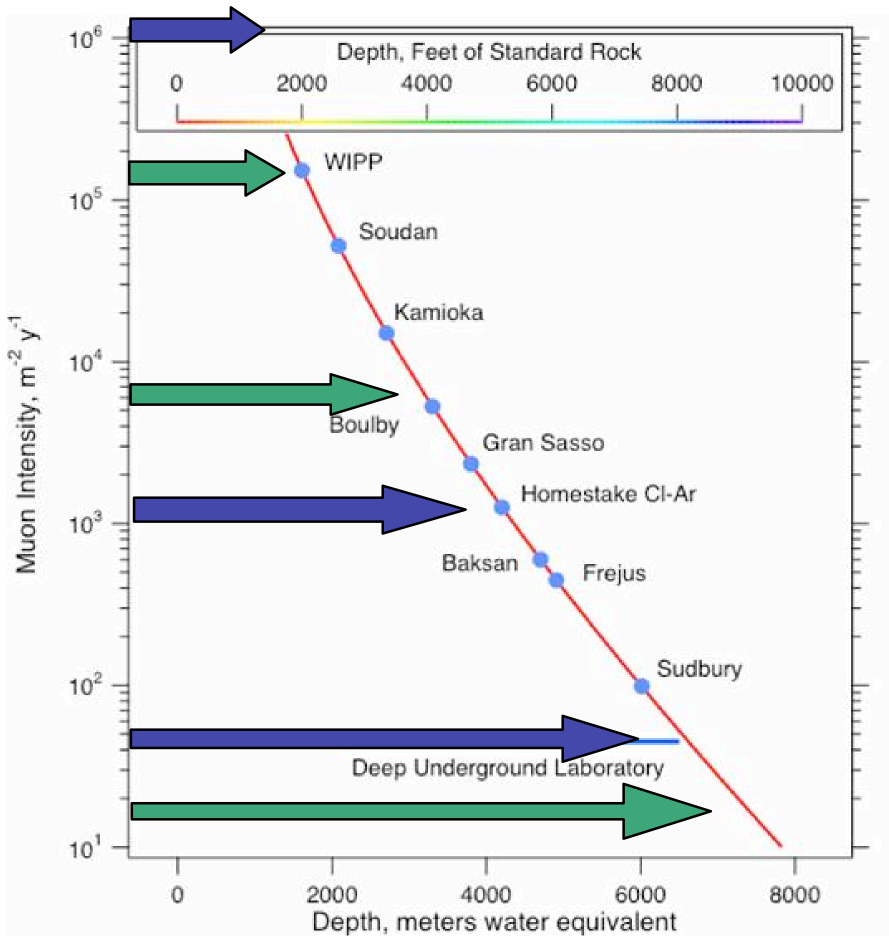
2000L Geo Level

3800L Geo Level

4850L Major Campus

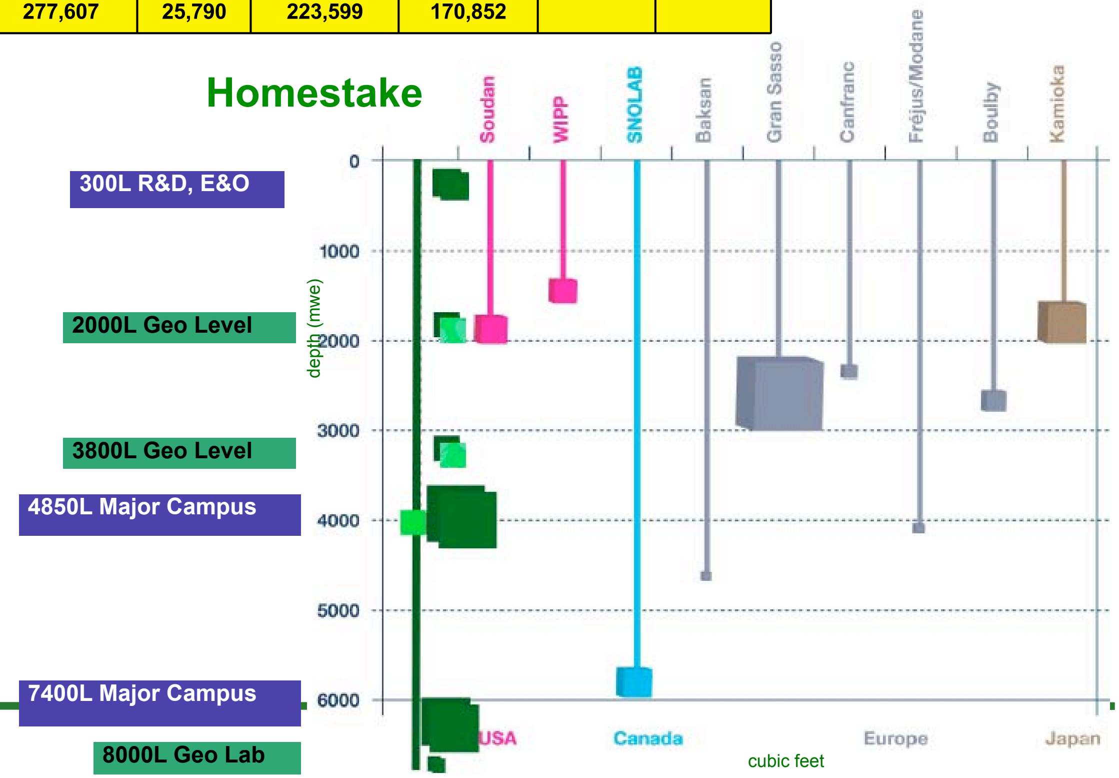
7400L Major Campus

8000L Geo Lab

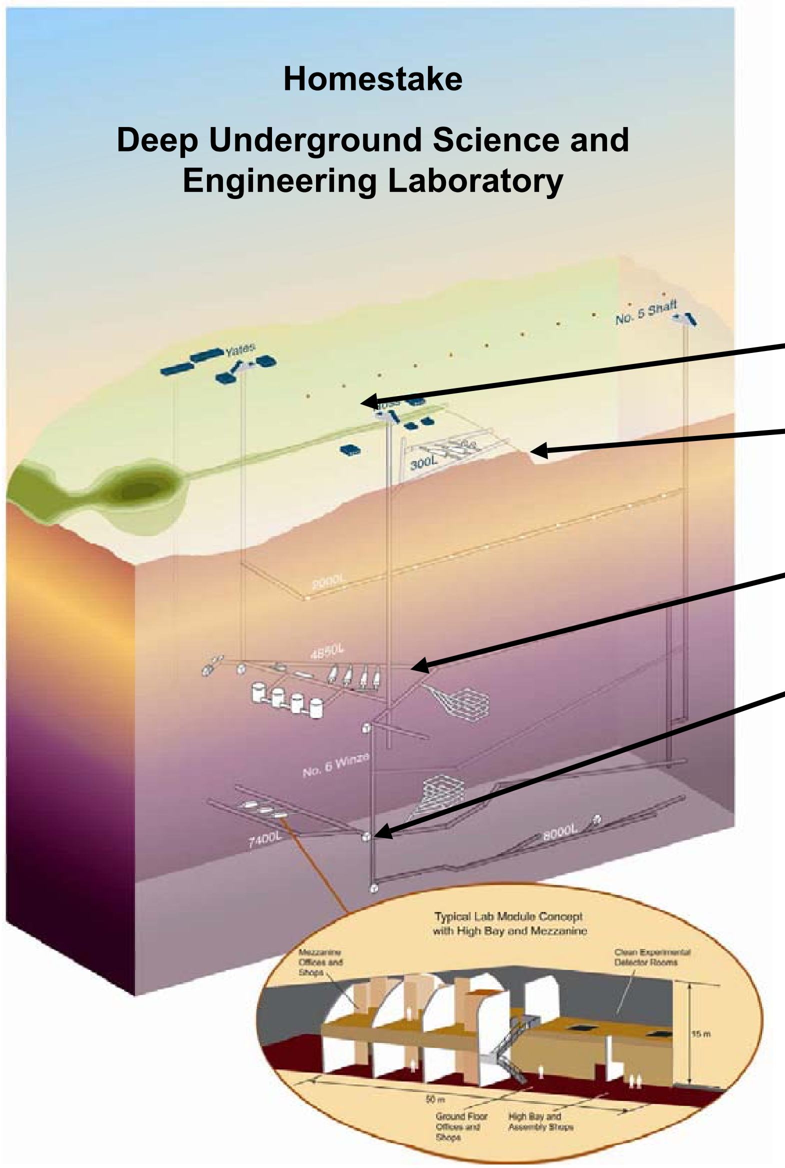


Campus Footprints

Homestake Interim Lab and DUSEL Summary of Development of Space and Availability (Underground Space Fully Outfitted and Ready for Detector Installation)	Labs, Shops, Offices Usable Floor Area		Excavation Volume (including access drifts)		Construction Schedule *to be revised*	
	sq. ft.	sq. m.	cu. yd.	cu. m.	Start	Finish
4850 Level Subtotal	**107,351**	**9,973**	**111,115**	**84,903**		
Ross Shops for Construction Staging	12,469	1,158	5,738	4,385	Apr-08	Dec-08
Davis Lab, Sanford Lab, and Bio-Geo Lab	15,738	1,462	13,543	10,348	Sep-08	Jul-09
Lab Module #1 and Common Facilities	26,464	2,459	25,155	19,221	Oct-10	Sep-12
Lab Module #2	17,560	1,631	21,433	16,377	May-11	Apr-13
Lab Module #3	17,560	1,631	23,121	17,667	Sep-13	Jul-15
Lab Module #4 (excavation only, without lab outfitting)	17,560	1,631	22,125	16,906	Aug-14	Jul-15
7400 Level Subtotal	**63,588**	**5,907**	**98,477**	**75,246**		
Lab Module #1 and Common Facilities	28,468	2,645	29,594	22,613	Jan-12	Mar-14
Lab Modules #2 and #3 (excavation only, without lab outfitting)	35,120	3,263	68,883	52,633	Dec-12	Jan-14
300 Level Subtotal	**8,668**	**805**	**14,007**	**10,703**		
Lab #1, Shops, and E&O Rooms	8,668	805	14,007	10,703	Nov-10	Nov-11
Surface Subtotal	**98,000**	**9,104**				
DUSEL Offices and User Support Areas,Phase 1	10,000	929			Dec-10	Jun-12
Sanford Clean Room and Assembly Shop	6,000	557			Dec-10	Jun-12
DUSEL Offices and User Support Areas,Phase 2	32,000	2,973			Jul-11	Jun-13
Sanford Center for Science Education	50,000	4,645			Sep-09	Sep-11
Total	**277,607**	**25,790**	**223,599**	**170,852**		



CONTENT: Homestake DUSEL Campus Development Concepts



Planning to develop four primary campus locations for research:

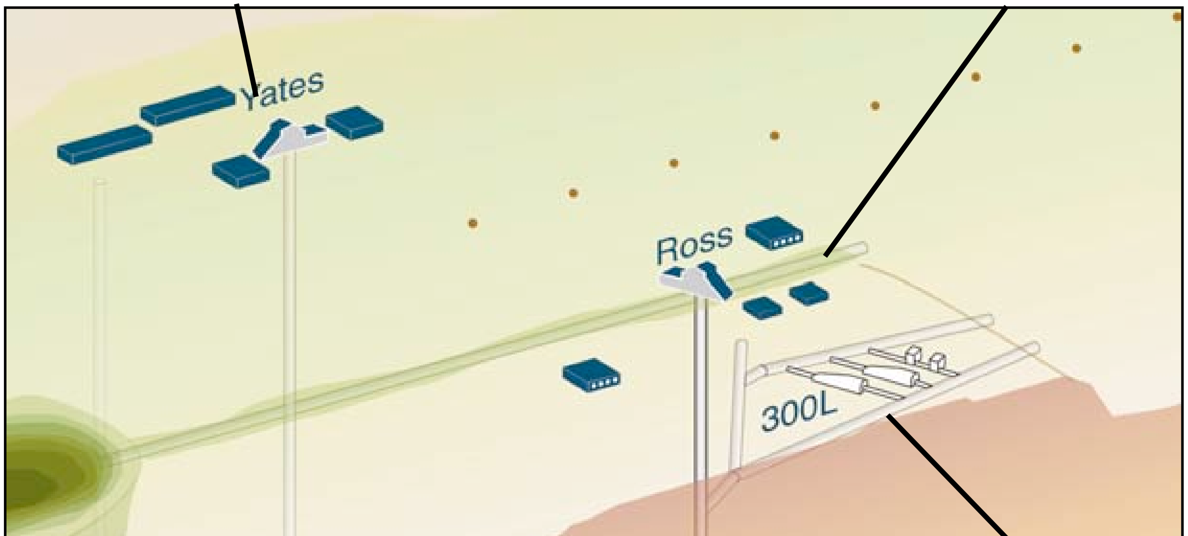
1. Surface campus at Yates Complex
2. Near-surface campus at 300 Level
3. Mid-level campus at 4850 Level
4. Deep-level campus at 7400 Level

Infrastructure will be maintained for access to additional, selected levels for bio- and geo- sciences and for unique experiments that require specific or isolated sites.

Campus Development Concepts for Surface Facilities and 300 Level

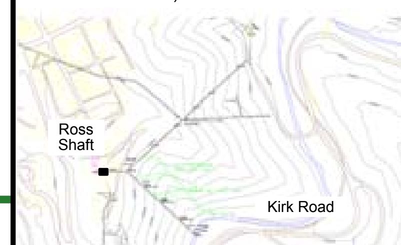
Yates Complex Surface Facilities:
- Laboratory Administration Building and Training
- User Support Services: Clean Room Assembly & Fabrication Shops
- R&D Laboratories, User Offices, Meeting Rooms
- Education and Outreach: Sanford Center for Science Education
- Shipping and Receiving, Storage

Ross Complex Surface Facilities :
- Construction Materials and Equipment Staging
- Construction Superintendents and Contractor Offices
- Maintenance Shops
- Shipping and Receiving, Storage
- Facility Site Services and Operations



Experiments and Facilities at 300 Level:
- Education and Outreach Classroom and Laboratory
- User Support Shops: Assembly, Fabrication and Underground Storage
- Research and Development Laboratories
- Near-surface Experiments
- Low-background Counting and Calibration Facility

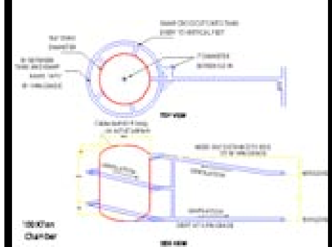
300 Level Campus Plan for near-surface, drive-in access



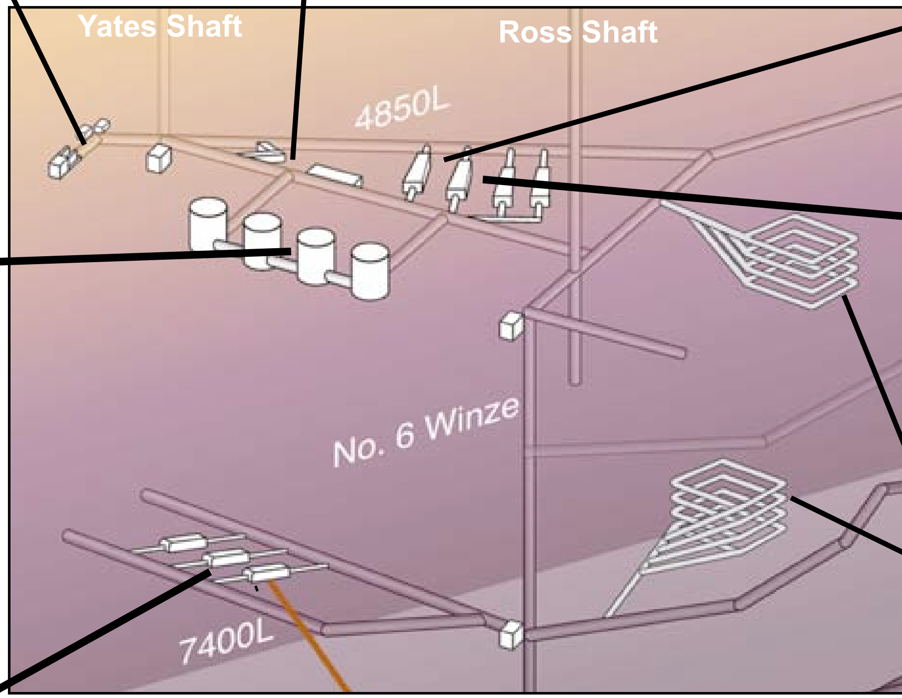
Campus Concepts for Mid- and Deep-level Experiments

Early Implementation Program & Facility Infrastructure Development at 4850L:

- Low-Background Counting Facility
- Neutrinoless Double Beta Decay
- Dark Matter
- Earth Sciences and Geo-microbiology Lab
- Common Facilities and Clean Room Transition
- Utility Services and Refuge Chamber



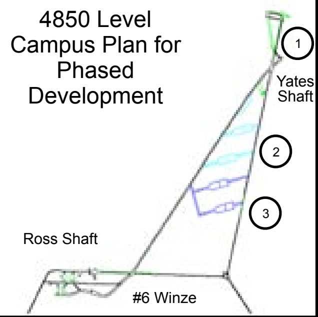
Design and Excavation concept for future, multiple 100 kTon chambers for Long Baseline Experiment



Initial Suite of Experiments at 4850 Level

- Dark Matter
- Double Beta Decay
- Nuclear Astrophysics
- Solar Neutrinos
- Geoneutrinos

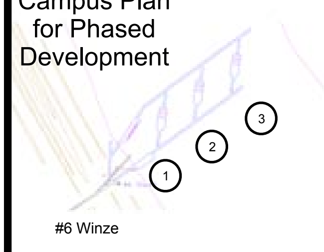
4850 Level Campus Plan for Phased Development



Geosciences:

Large Block Coupled Processes Experiments

7400 Level Campus Plan for Phased Development



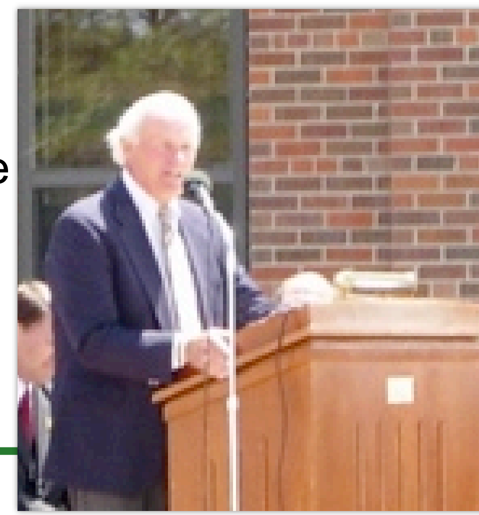
Initial Suite of Experiments at 7400 Level:

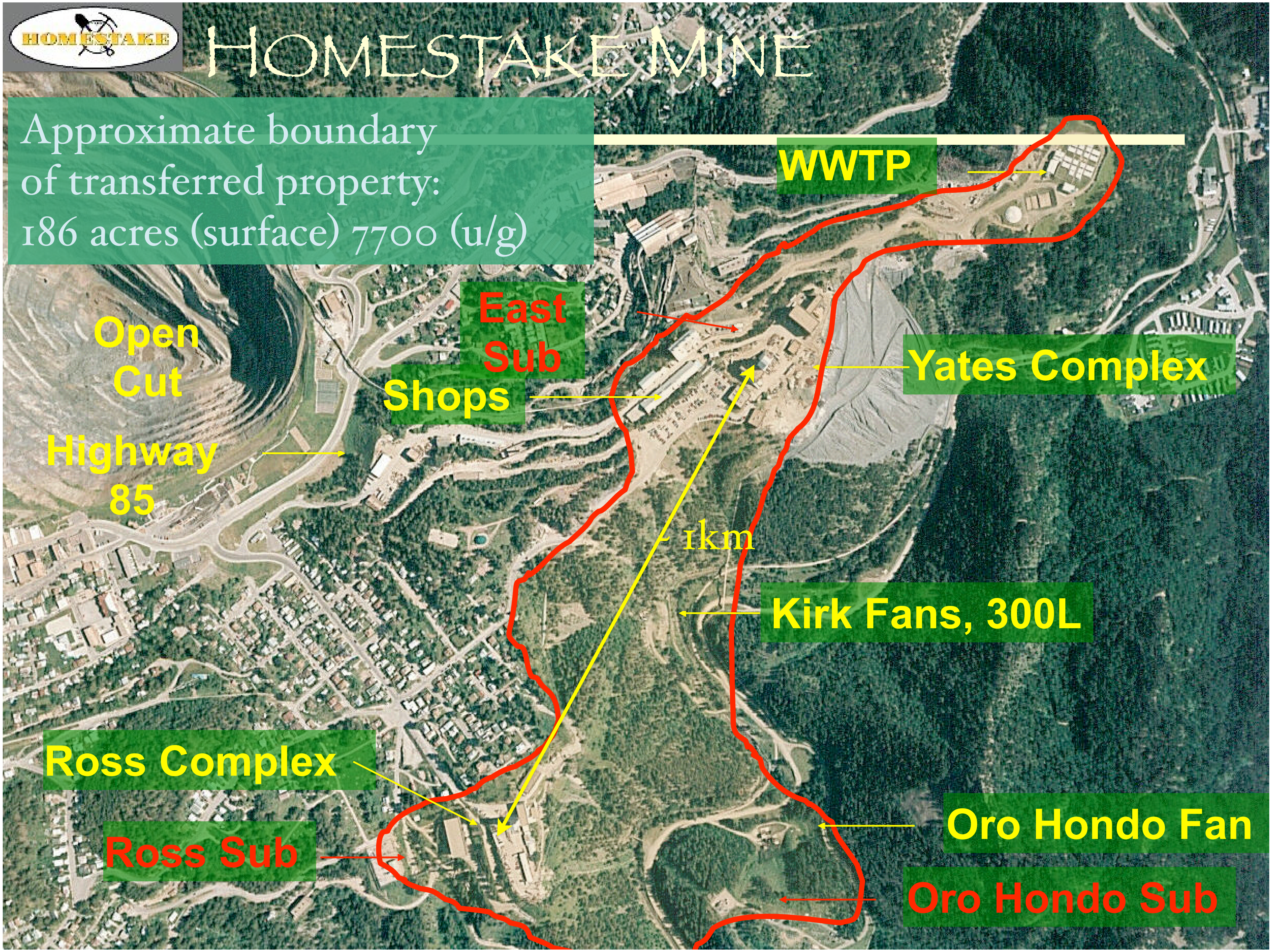
- Large Double Beta Decay
- Solar Neutrinos
- Supernovae Detection
- Large Dark Matter

Phased Approach to Creating DUSEL

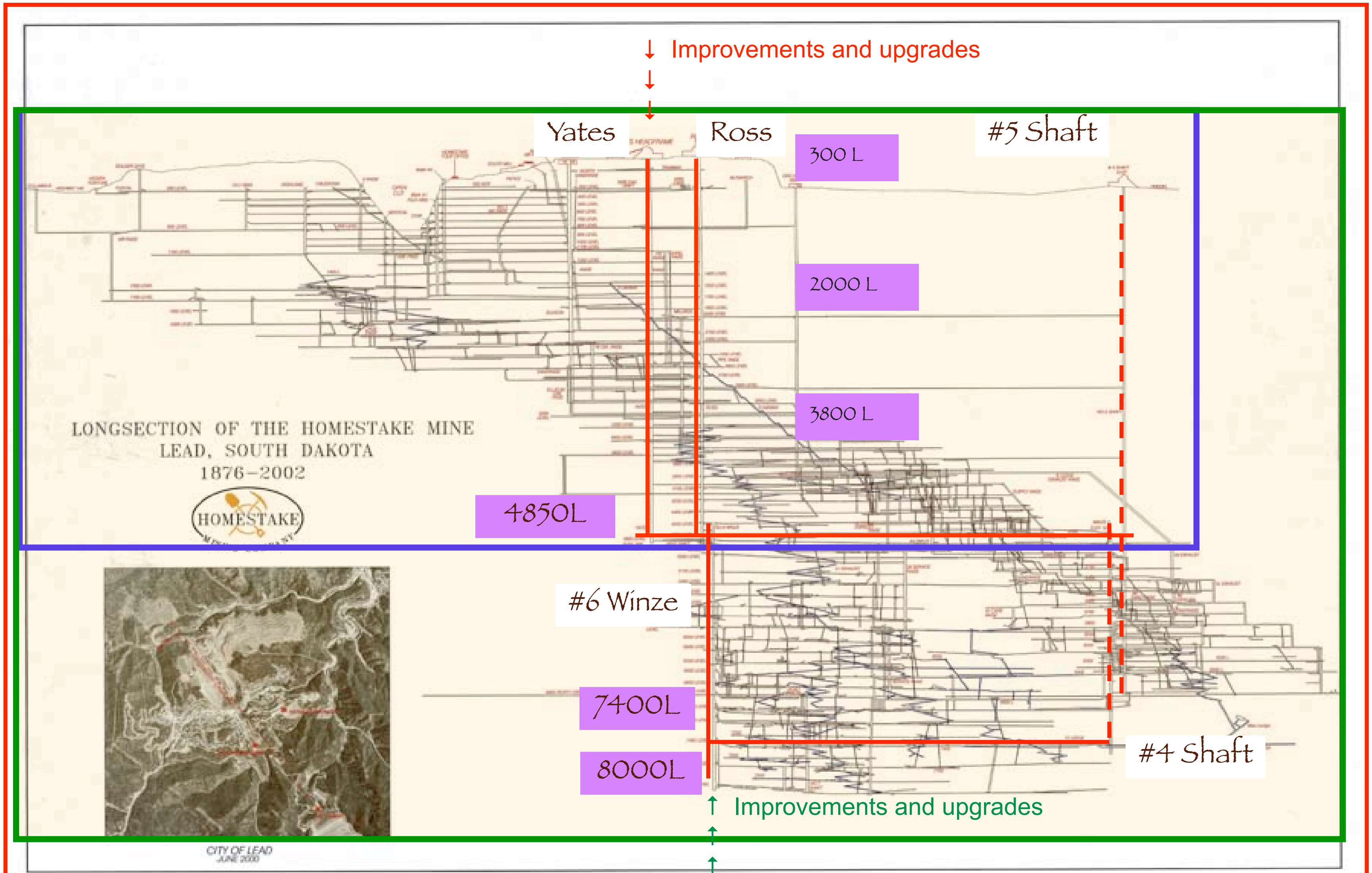
- To preserve the site for DUSEL, South Dakota initiated a program of rehabilitation and re-entry. Will host a modest Science Program with these efforts
- Motivated by the desire to halt the in-flow of water into the facility
- Financed with State-controlled funds and philanthropic donations

- ☑ October 2005, State Legislature approves additional $20M funding for Homestake, <u>total of $46M</u> from state controlled sources.
  - Rehab plan: $15M
  - Indemnification fund: $10M
  - Operations: $15M   Insurance: $2.5M
  - Contingency: $3.5M
- ☑ 1 November 2005 - First call: Letters of Interest for Homestake ~ 85 letters responses
- ☑ Property Donation Agreement Completed 14 April 2006, Property transfered to S.D. May 2006, SDSTA hiring staff to oversee and operate Homestake: ~30 for rehabilitation, ~ 25 to 30 staff members
- ☑ Banker and philanthropist T. Denny Sanford pledges **<u>$70M</u>** to develop Sanford Lab at Homestake
- ☑ January 2007 Rehab work initiated
- ☑ October 2007 SDSTA hires Jose Alonso, Lab Director; active searches for Project Managers, Project Engineers, Safety Director, other Sanford Lab staff
- ○ Early Implementation Program at Homestake 2007 - 2012 "The Sanford Laboratory"




HOMESTAKE
Homestake Mine
Approximate boundary
of transferred property:
186 acres (surface) 7700 (u/g)
WWTP
East
Sub
Yates Complex
Open
Cut
Shops
Highway
85
1km
Kirk Fans, 300L
Ross Complex
Oro Hondo Fan
Ross Sub
Oro Hondo Sub

Phased approach to building DUSEL at Homestake



A dedicated science facility without competition or interference from mining, transportation, etc.

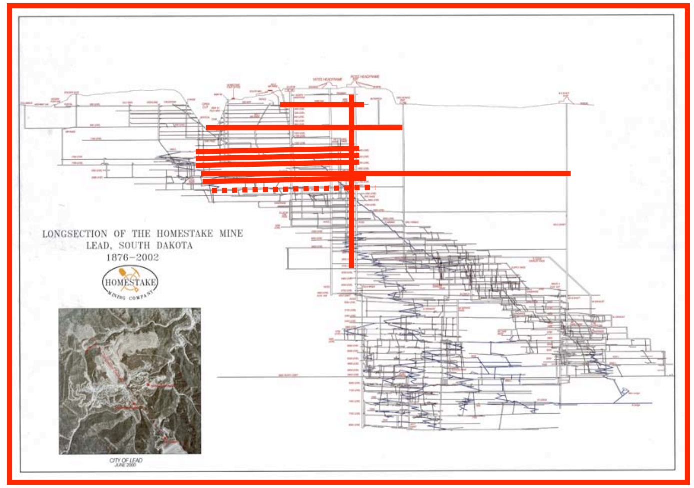
Homestake's Plans & Activities

- Near-Term rehabilitation of Ross and Pumping
  - Φ1 - Surface work, buildings hoists, ventilation equipment: December 06 - April 07
    - ☑ Video inspection of Shafts
    - ☑ Ross Hoists operational 22 March
    - ☑ Ventilation fans installed and operations (100-120 kcfm)
    - ☑ First water samples from u/g

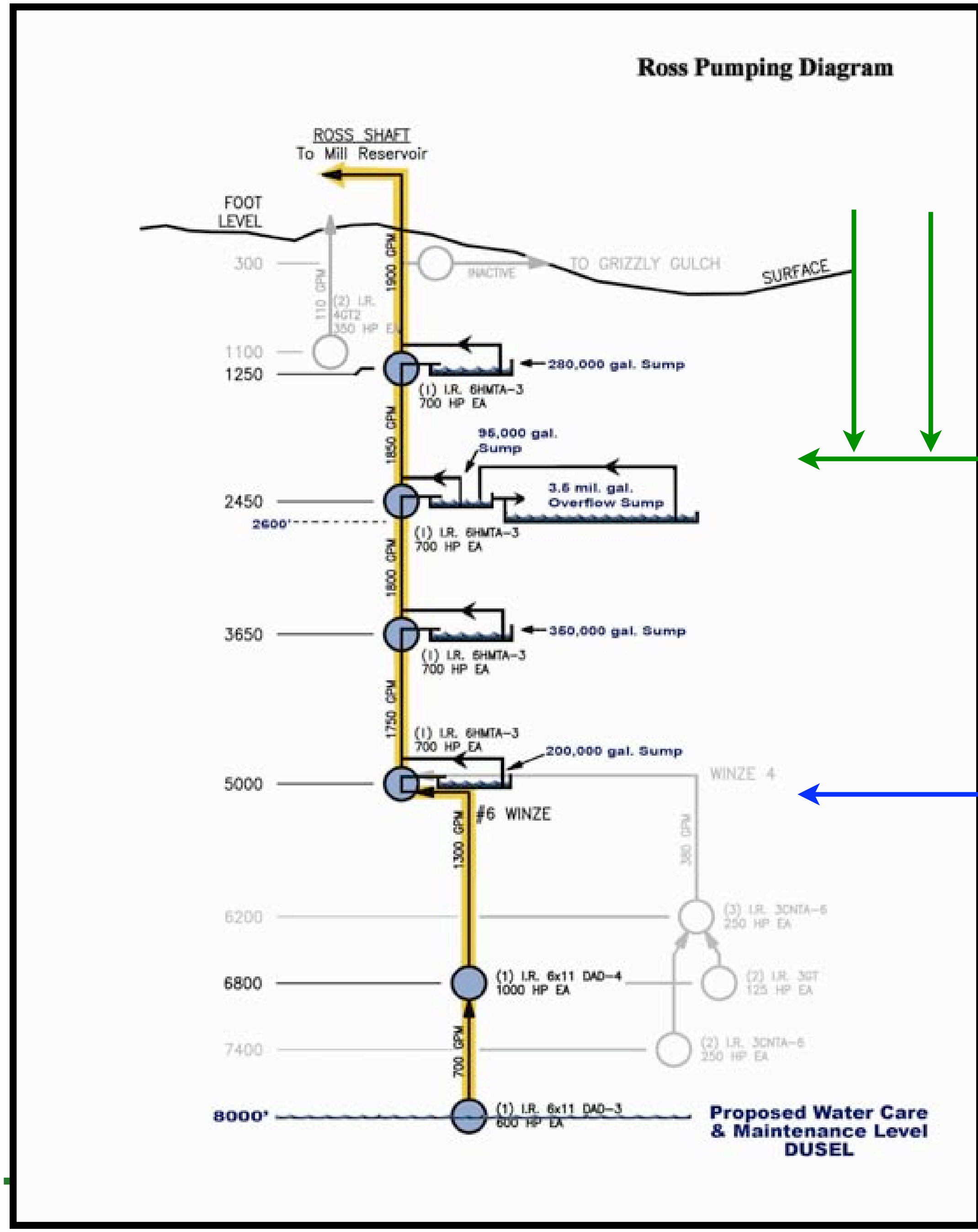
  - Φ2 - Underground work, including shaft and pumping, April 07 - December 07
  - Φ3 - Equipment Operation September 07 - May 08

Re-entering Homestake and establishing the Sanford Laboratory

- **<u>Second and Third Phase work</u>**
- Shaft Inspections and Maintenance (Ross then Yates)



- Level Inspections
- Pumping
- Ventilation
- Early Implementation Program at the Sanford Lab

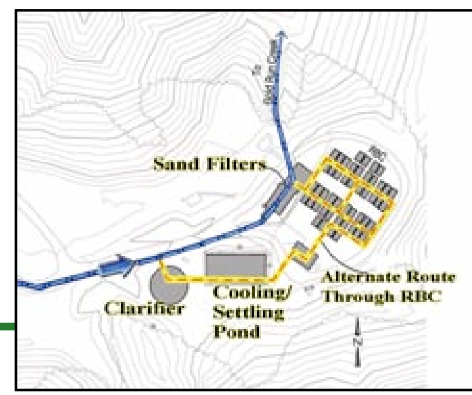


Dewatering Homestake - Current Water Levels

<u>Re-entry Efforts</u>, begun in July, have inspected levels and shafts down to 2100 L

Focus on turning on pumps at 1250L and 2450L

5000 level sensor tripped July 2007(6 weeks earlier than original model)



Re-entry Timeline

SDSTA plan for installation of Ross Shaft Pumping System to hold the accumulated water below the 5300 L

Target completion to initiate pumping by in 2007

The first of the Sanford Lab Science Program Initiated: geology, hydrology, biological sampling taking place with re-entry

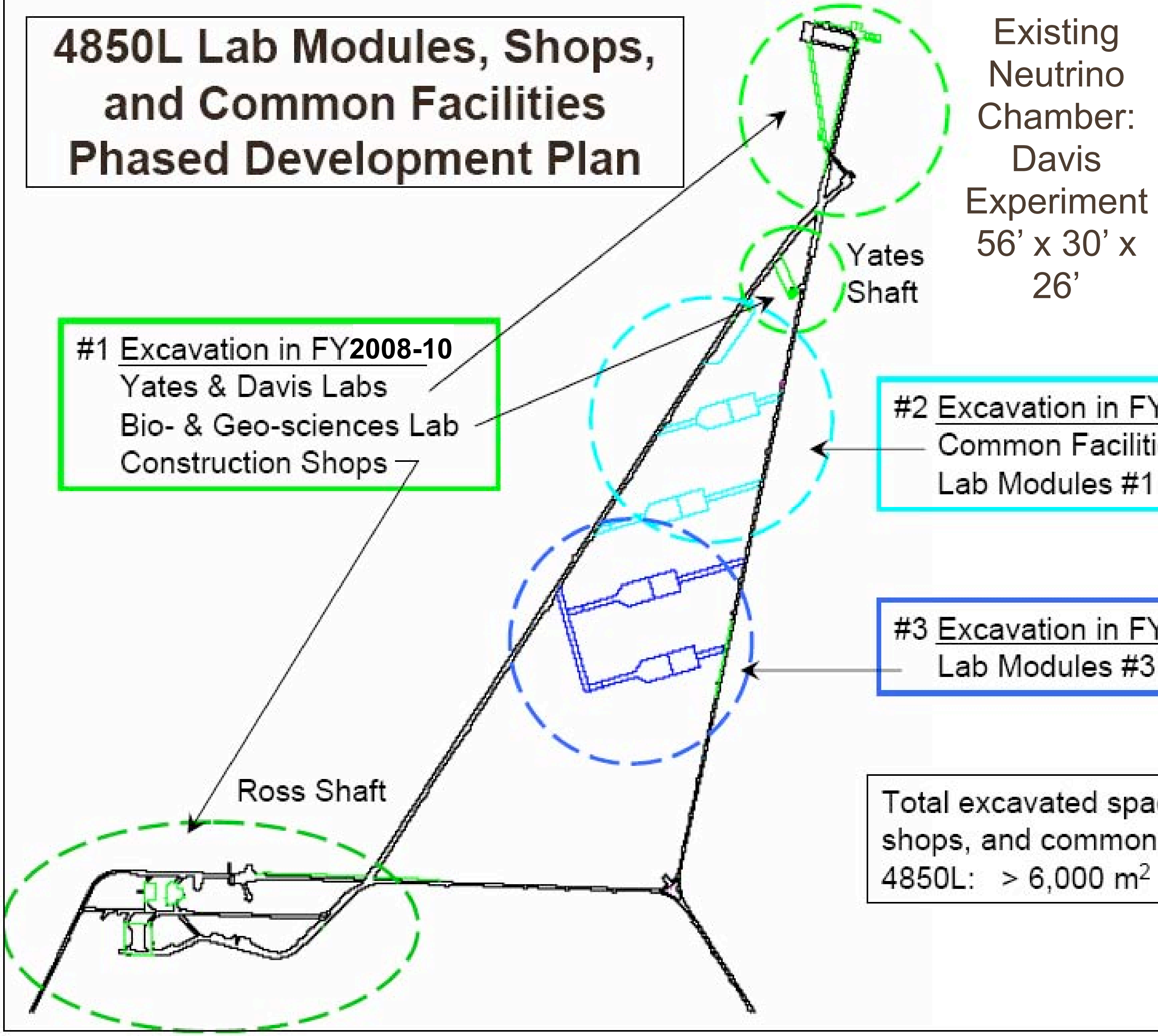
Early Implementation of the Conversion Plan

- Foremost purpose was to preserve Homestake for DUSEL
- Taking advantage of State funded laboratory: 2007 - 2012
- **300 L**, **4850 L**, and other levels, e.g. **2000 L, 3800 L**
- Ross and Yates Shafts refurbished, safe and operating cages
- Basic operations including Safety, Utilities, & Services
- Upgrades and enhancements as budget permits
- Program based on an International Call for Letters of Interest
- Active Program Advisory Committee
  (LOIs and PAC report can be found on www.lbl.gov/nsd/homestake

Sanford Lab's Early Program

Experiment Name	PI(s)	Institution	Letter of Interest	Memorandum of Understanding	Brief Description	
LUX: Development of a large liquid xenon dark matter detector	Rick Gaitskell Tom Shutt and collaboration	Brown Case Western	Yes	Yes	Direct Detection of Dark Matter using cryogenic liquid Xe, detection of signals and separation of signal from background using scintillation light. Detector requires several meters of water shielding to reduce backgrounds. 4850L Davis Cavity is appropriate	Dark Matter
Collaborative Research Towards Transparent Earth	Steven Glaser Lane Johnson Bill Roggenthen and collaboration	UCB UCB SDSM&T	Yes	Yes	This proposal presents a plan to install and operate a permanent seismic observatory illuminating the volume of the Homestake Mine from all six possible directions. We have chosen the Homestake DUSEL site because it offers a unique opportunity - the large volume of mine working of the deepest mine in North America is surrounded and underlain by literally hundreds of open bore holes, which can affordably be instrumented with accelerometers.	Geo/seismic array
Low Background Counting Facility, DOE BES ESPSoR	Dongming Mei Bill Roggenthen and collaboration	USD SDSM&T	Yes	Yes	Develop a state-of-the-art Low Background Assay Facility in the Davis Cavity (4850L)	Low Background Counting
miniCLEAN	Andrew Hime Dan McKinsey and collaboration	LANL Yale	Yes	MOU under discussion	Direct Detection of Dark Matter using cryogenic noble gases.	Dark Matter
Liquid Argon Dark Matter	Dongming Mei Andrew Hime and collaboration	USD LANL	Yes	MOU under discussion	Direct Detection of Dark Matter using cryogenic noble gases.	Dark Matter
Homestake: Biological, Chemical and Geological Sampling	Sookie Bang Mark Conrad and collaboration	SDSM&T LBNL	Yes	Yes	Site Characterization and baseline establishment for biology, chemistry, hydrology, and geology	Geo/Bio
Majorana: Neutrinoless double beta decay R&D	John Wilkerson Steve Elliott and collaboration	U.W. LANL	Yes	MOU being developed August 2007	Development of ultrapure materials, low background counting and Ge detector demonstration module	Neutrinoless $\beta\beta$
Large Cavity Development and R&D	Milind Diwan Ken Lande and collaboration	Brookhaven Penn	Yes	Yes	Develop plans for large cavities and water-Cerenkov detectors for nucleon decay and long baseline neutrino experiments	Large Cavities, LBL νs
Carbon Sequestration Experimental Design	Joe Wang and collaboration	LBNL	Yes	MOU being developed November 2007	Development of experimental designs for carbon sequestration facilities and the behavior of super-critical CO2 in the underground	Carbon Sequestration

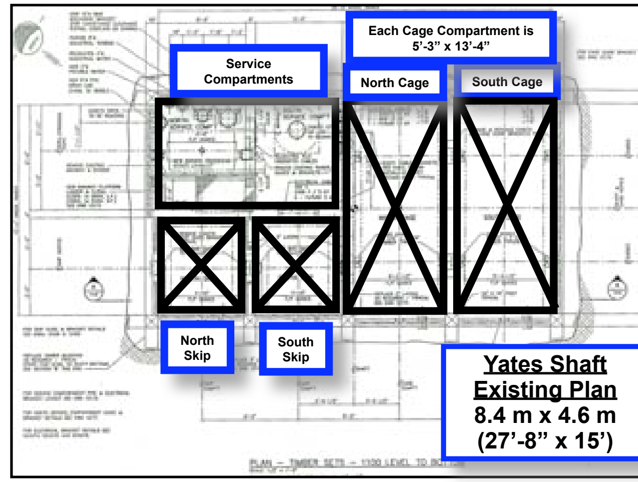
4850L Lab Modules, Shops, and Common Facilities Phased Development Plan



Existing Neutrino Chamber: Davis Experiment 56' x 30' x 26'

Yates Shaft Upgrade Plan

Improved access to the 4850 Level for personnel, equipment, and utilities



Existing Cage Dimensions and Capacities

Yates Cage Hoist

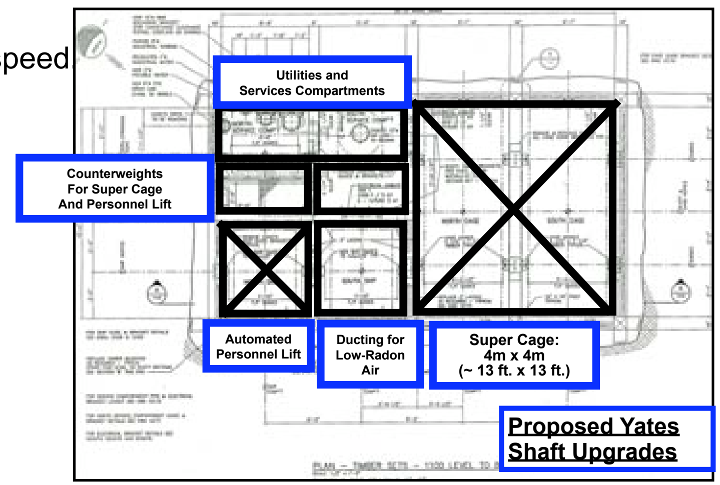
Maximum cage dimensions: 1.4 x 3.7 x 2.2m high (side-by-side)
(4' 8" x 12' 1.5" x 7' 2" high)
Maximum cage payload: 5,450 kg (12,000 lb), nominal
5,900 kg (13,000 lb), allowable at 1/2-speed

Ross Cage Hoist

Maximum cage dimensions: 1.3 x 3.8 x 2.2m high (double deck)
(4' 4-5/8" x 12' 5" x 7' 2" high)
Maximum cage payload: 5,450 kg (12,000 lb, nominal
6,100 kg (13,400 lb), allowable at 1/2-speed.

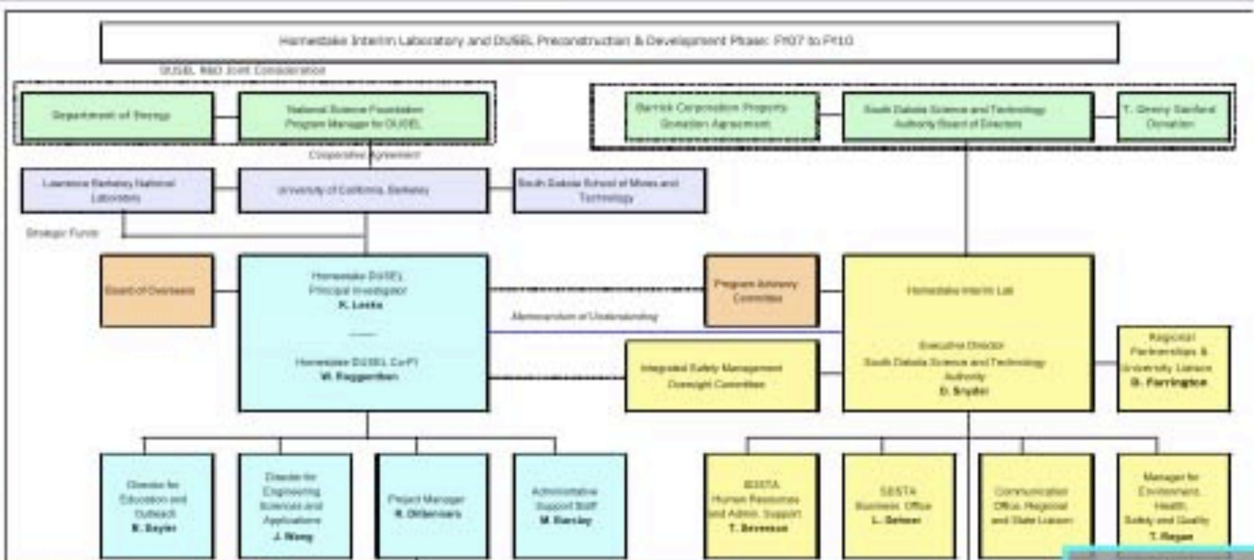
#6 Winze Cage Hoist

Maximum cage dimensions: 1.3 x 3.7 x 2.2m high (double deck)
(4' 4" x 12' 1-1/2" x 2.2m high)
Maximum cage payload: 5,450 kg (12,000 lb), nominal
6,400 kg (14,000 lb), allowable at 1/2-speed.



Homestake Organization & Interim Laboratory Operations Prior to MREFC

Scientific Program & Scientific Requirements - Homestake Scientific Collaboration



Facility Development - SDSTA

Development of Homestake Interim Facility

Oversite and Review

Collaboration Executive Committee
Board of Overseers
Internal Review Committees
SDSTA Board

Scientific and Safety Programs

Program Advisory Committee
Safety Management Committee

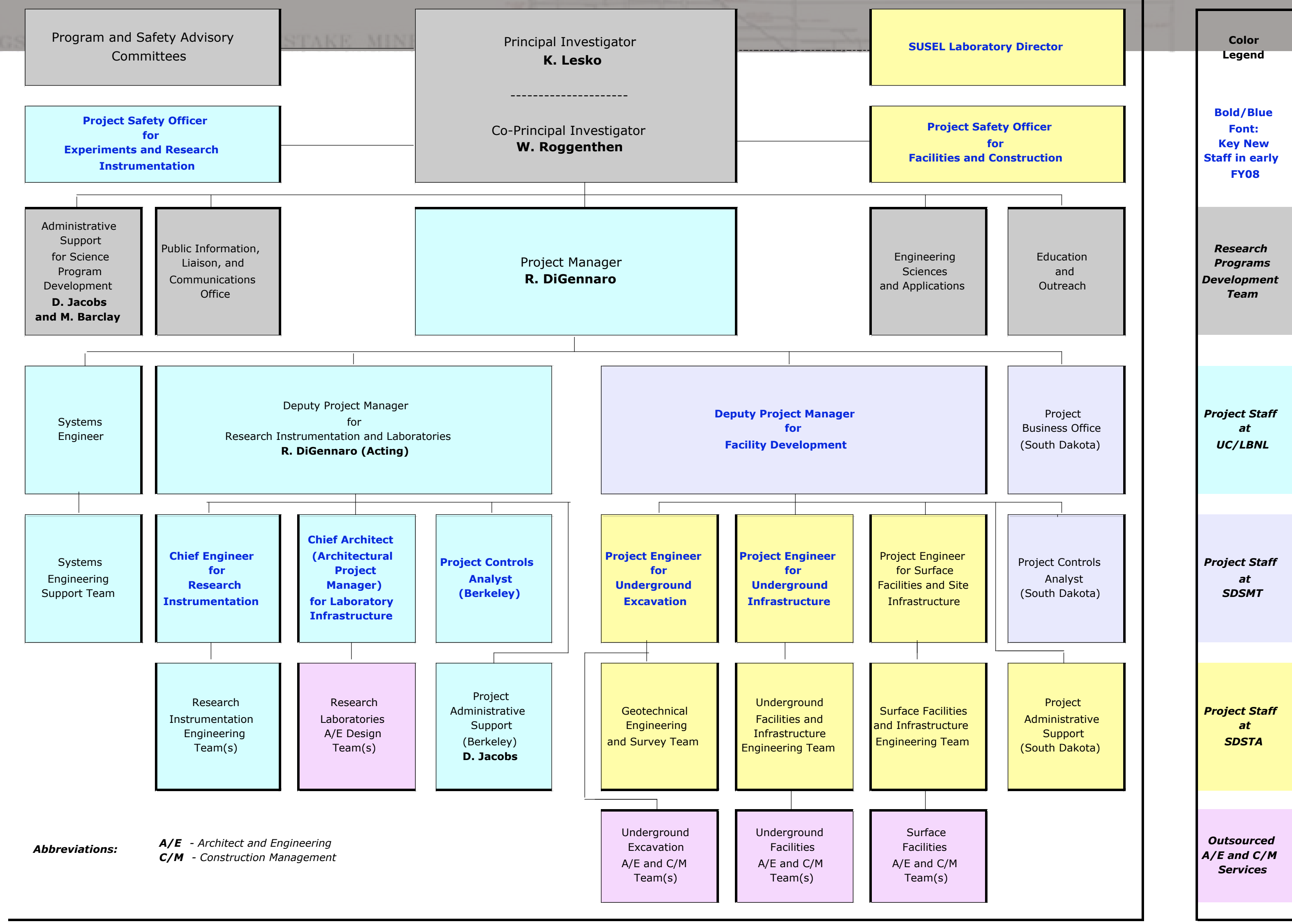
Reports and Consultant Services

Golder Associates
Syd DeVries
Mark Laurenti
Dynatec Corp
RESPEC
NIOSH

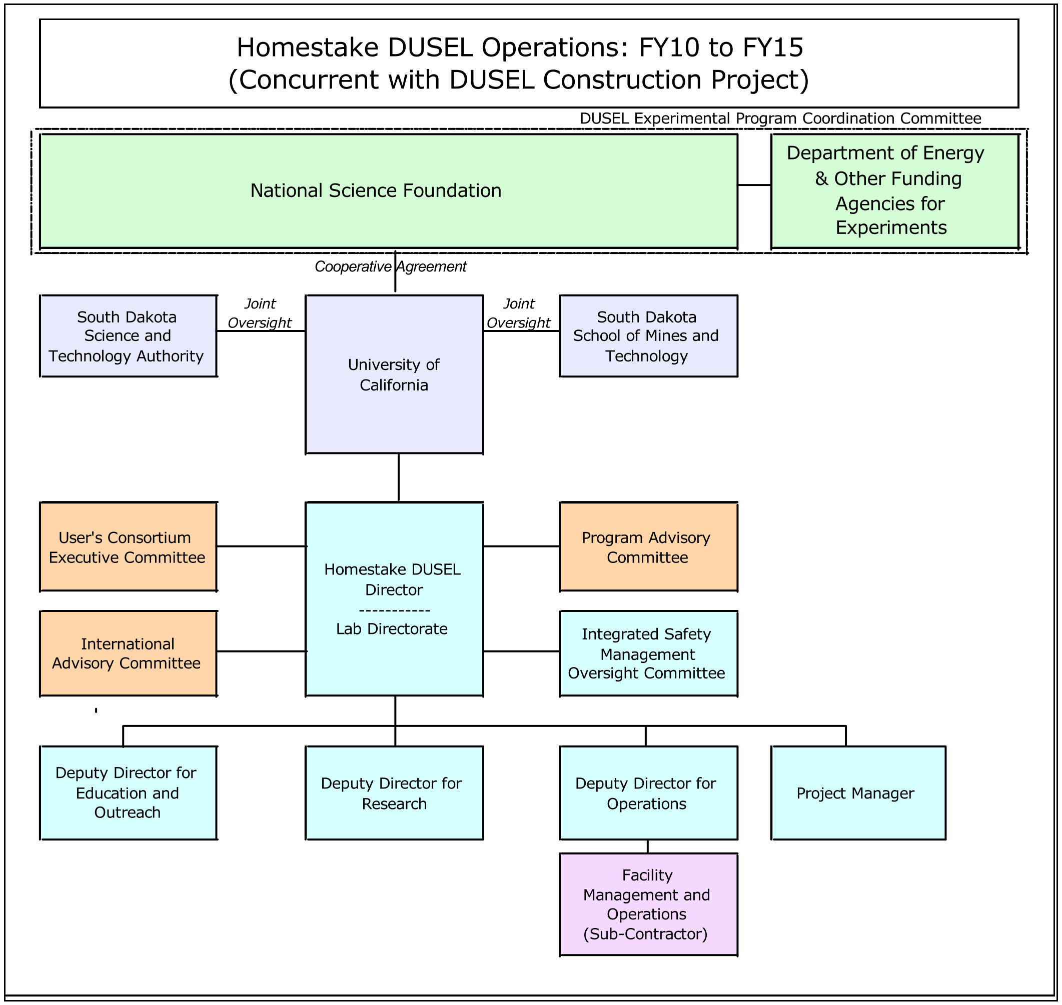
Additional Support

SDSTA Staff and Contractors
SD Office of State Engineer
Former HMC Staff
SDGS
CAMSE, QuarkNet
Workshops, LOIs, MOUs
Homestake MC

Homestake DUSEL Project Organization for
NSF MREFC Pre-Construction Planning and Development
Research Programs Development, Project Management, and Project Engineering



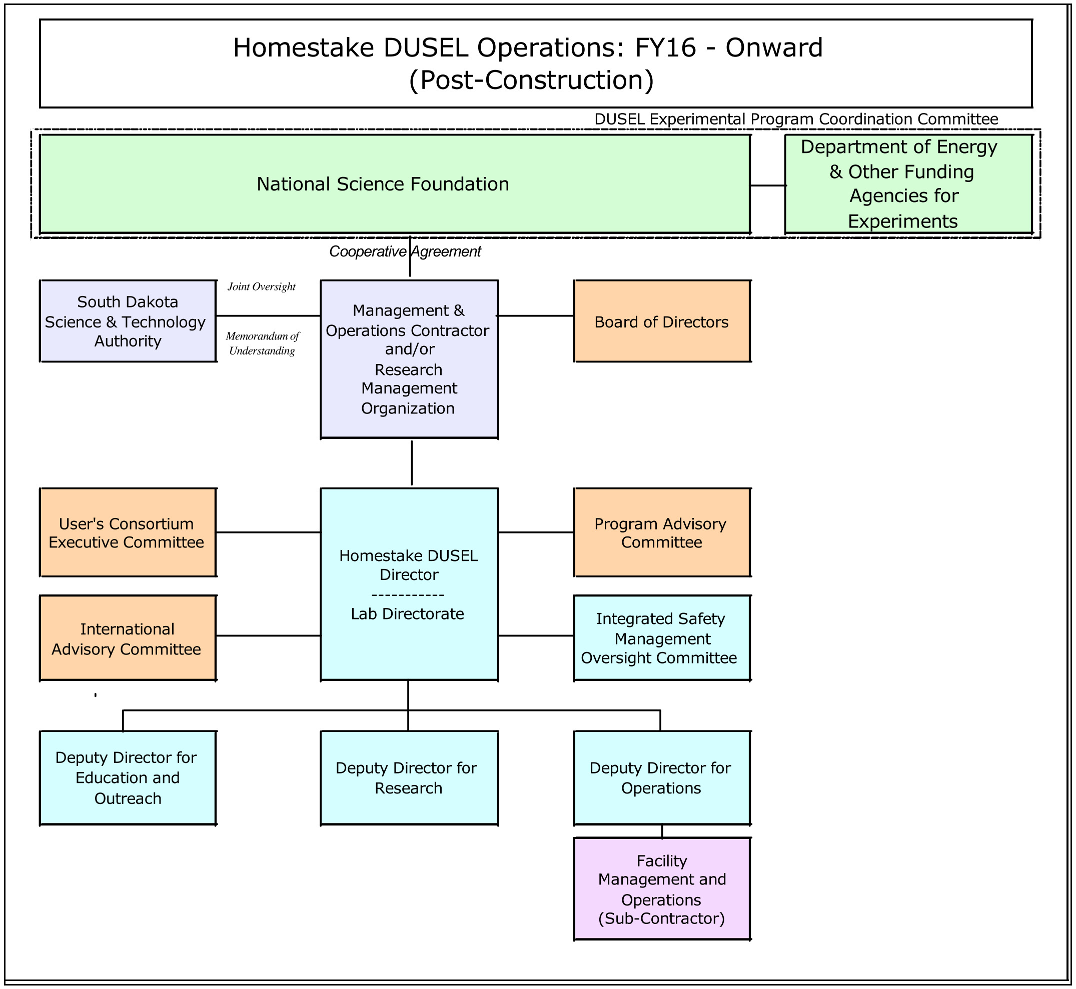
Homestake Organization through the MREFC



Consolidate Organization to Develop DUSEL

Many Trained Staff Transition Directly into MREFC Efforts

Homestake Organization during DUSEL Operations



Introduce Laboratory M&O Contractor / Entity

Many Staff Positions Transition into DUSEL

Preconstruction Planning and Development Phase for Homestake Deep Underground Science and Engineering Laboratory

We are moving into the MREFC Readiness Stage to develop a Preliminary Design including:

Richard DiGennaro

Project Manager
Systems Engineer

Content:

- Scientific research objectives and priorities
- Site-specific preliminary design
- Resource-loaded Schedule
- Bottoms-up Preliminary Cost Estimate
- Integrated Risk Analysis and Contingency Estimates
- Preliminary Operations Cost Estimate
- Environmental assessments

Process:

- Project Execution Plan
- Project Management Control System
- Systems Engineering

Systems Engineering Toolkit

<u>Objective:</u> Implement a unified approach to Systems Engineering and Project Management

- Communication
- Requirements Management Database
- Continuous Risk Management
- Work Breakdown Structure, Subsystem Interface Management
- Integrated Safety Management
- Design-Reviews, Integration, and Performance Management
- Value Management
- Configuration Management and Change Control
- Project Controls: Earned Value Management System

PROCESS: Homestake DUSEL Environment, Health & Safety

1. **Environment, Health and Safety and Integrated Safety Management**

    1.1 Integrated Safety Management Plan

    1.2 Environmental Laws, Regulations, and Best Practice
    - 1.2.1 Regulatory Agencies and Jurisdiction
    - 1.2.2 Permitting, Codes, Standards and Regulatory Compliance
    - 1.2.3 Environmental Assessment and Environmental Impact Statement
    - 1.2.4 Environmental Monitoring Program

    1.3 Hazardous Material Management

    1.4 Regional communication and public information

    1.5 Emergency Management, Response and Communication
    - 1.5.1 Fire Prevention, Containment, and Monitoring
    - 1.5.2 Safeguards and Security
    - 1.5.3 Regional resources and cooperative agreements

(continued)

PROCESS: Homestake DUSEL Environment, Health & Safety

1. **<u>Environment, Health and Safety and Integrated Safety Management (cont.)</u>**

    1.6 Safety Training Programs and Oversight
    - 1.6.1 Staff/Employees
    - 1.6.2 Experimenters, Students, Visitors, and Guests
    - 1.6.3 Contractors, consultants, services

    1.7 Safety Review Process, Inspection, Surveillance and Oversight
    - 1.7.1 Construction
    - 1.7.2 Experiments
    - 1.7.3 Maintenance and Operations

    1.8 Recycling and Waste Disposal Plans

    1.9 Energy Conservation Performance and Energy Management

    1.10 Facility Life Cycle Plan, De-integration and Disposal (D&D)
    - 1.10.1 Laboratory Closure Plan

PROCESS: Homestake DUSEL Project Execution Plan

2. Project Execution Plan

2.1 Research Objectives Summary

2.2 Preliminary Baseline Performance Key Parameters

2.3 Project Governance and Management Organizational Plan
    2.3.1 Sub-awards and Organizational Responsibilities

2.4 Work Breakdown Structure (WBS)
    2.4.1 WBS for MREFC Construction Project
    2.4.2 WBS for Operations
    2.4.3 WBS Dictionary

2.5 Project Resource-Loaded Schedule
    2.5.1 Preconstruction Planning and Development
    2.5.2 MREFC Construction

(Continued)

PROCESS: Homestake DUSEL Project Execution Plan

2. Project Execution Plan (continued)

2.6 Project R&D Plan
- 2.6.1 Preliminary Site Investigation: Coring and Geotechnical Analyses
- 2.6.2 Excavation methods and technologies
- 2.6.3 Feasibility studies for Large-span Cavities
- 2.6.4 Site-specific Safety Standards and Guidelines
- 2.6.5 Underground systems and controls for hazardous materials
- 2.6.6 Underground Communications, Cyberinfrastructure, IT, and monitoring systems
- 2.6.7 Large-scale Reduced-radon Air Supply
- 2.6.8 Large-scale underground clean rooms
- 2.6.9 Large-scale purified water systems

2.7 Internal and Institutional Project Oversight and Design Review Plan

2.8 Acquisition Plan and Project Delivery Methods

(Continued)

PROCESS: Homestake DUSEL Project Execution Plan

<u>2. Project Execution Plan</u> (continued)

2.9 Systems Engineering Plan
- 2.9.1 Requirements Management
- 2.9.2 Continuous Risk Management
- 2.9.3 Configuration Management
- 2.9.4 Quality Assurance and Quality Control
- 2.9.5 Value Management
- 2.9.6 Interface Control
- 2.9.7 Systems Integration, Testing, and Validation
- 2.9.8 Information, Communication and Document Management

2.10 Project Management Control System
- 2.10.1 Baseline Cost and Schedule Performance Parameters
- 2.10.2 Resource-loaded Project Schedule
- 2.10.3 Preliminary Risk Analysis and Risk Mitigation
- 2.10.4 Preliminary Cost Estimate and Contingency Analysis
- 2.10.5 Partnerships and Partnership Funding
- 2.10.6 Project Controls and Earned Value Management
- 2.10.7 Technical and Financial Oversight, Reporting, and Reviews
- 2.10.8 Change Control and Contingency Management
- 2.10.9 Project Staffing and Hiring Plan

PROCESS: Homestake DUSEL Project Execution Plan

3. Summary: Technical Feasibility and Constructability

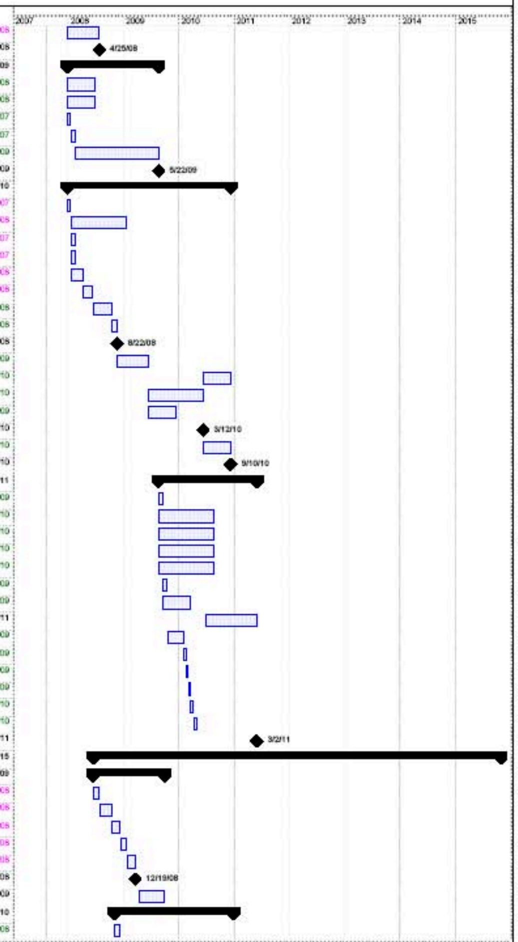
4. Transition to Operations

4.1 Operational Readiness Criteria
4.2 Commissioning
4.3 Conduct of Operations Plan
4.4 Operations Management Plan
4.5 Maintenance and Operations Plan

The resource-loaded schedule for the CDR integrates and links all estimated costs with the sequence of activities for design and construction

Deep Underground Science and Engineering Laboratory at Homestake

ID	Area	Sub Project	Risk Category	Funding Category	Funding Source	WBS	Task Name	Predecessors	Start	Duration	Finish
723	RE	MTL	RE	HL	SDSTA	1.6.4.1.11	Install Yates Shaft Ventilation Bulkheads	722	10/1/07	30 wks	4/25/08
724						1.6.4.1.12	Re-entry for safe Access to 4850L complete	722,715	4/25/08	0 wks	4/25/08
725						1.6.4.2	Dewatering		10/1/07	86 wks	5/22/09
726	RE	MTL	RE	Gift 3	Sanford	1.6.4.2.1	Cooling Tower for dewatering deep levels	730SF,8	10/1/07	26 wks	3/28/08
727	RE	MTL	RE	Gift 3	Sanford	1.6.4.2.2	Water Treatment Plant Alterations for TDS and other contaminants	730SF,8	10/1/07	26 wks	3/28/08
728	RE	MTL	RE	Gift 3	Sanford	1.6.4.2.3	Mobilization for Dewatering and Mid-Levels upgrades	718	10/1/07	3 wks	10/19/07
729	RE	MTL	RE	Gift 3	Sanford	1.6.4.2.4	Rehab. Ross pumping systems for Dewatering	728	10/22/07	5 wks	11/23/07
730	RE	MTL	RE	Gift 3	Sanford	1.6.4.2.5	DEWATERING: Electricity for (Temporary) Dewatering for Deep Le	729	11/23/07	78 wks	5/22/09
731						1.6.4.2.6	Dewatering to 8000L Complete	730	5/22/09	0 wks	5/22/09
732						1.6.4.3	Mid Levels Infrastructure Rehabiliation, Upgrades and Scope Optic		10/1/07	154 wks	9/10/10
733	RE	MTL	RE	HL	SDSTA	1.6.4.3.1	Mobilization to 4850L and Set-up for Mid-Levels Mine Upgrades ar	718	10/1/07	3 wks	10/19/07
734	RE	MTL	RE	HL	SDSTA	1.6.4.3.2	Upgrade Mid-Levels Mine Electrical Power Supply and U/G Distrib	733,714	10/22/07	52 wks	10/17/08
735	RE	MTL	RE	HL	SDSTA	1.6.4.3.3	Rehab-3950L and Clear Oro Hondo Shaft Bottom	733	10/22/07	4 wks	11/16/07
736	RE	MTL	RE	HL	SDSTA	1.6.4.3.4	4850L Rehab drifts from Ross to #5 shaft for exhaust ventilation)	733	10/22/07	4 wks	11/16/07
737	RE	MTL	RE	HL	SDSTA	1.6.4.3.5	Ross Upgrades: Recommission Production Hoists	733	10/22/07	12 wks	1/11/08
738	RE	MTL	RE	HL	SDSTA	1.6.4.3.6	Ross Upgrades: Install Winch, A-Frame and Cross Head	737	1/14/08	9 wks	3/14/08
739	RE	MTL	RE	Gift 1	Sanford	1.6.4.3.7	Ross Upgrades: Install Guides and Replace Services	738	3/17/08	18 wks	7/18/08
740	RE	MTL	RE	Gift 1	Sanford	1.6.4.3.8	Ross Upgrades: Re-hab Shaft Sets, complete shaft re-hab.	739	7/21/08	5 wks	8/22/08
741						1.6.4.3.9	Ross - Basic Rehab complete	740	8/22/08	0 wks	8/22/08
742	RE	MTL	RE	Gift 1	Sanford	1.6.4.3.10	Yates Upgrades: Replace remaining timber sets at 800L-3050L	741	8/25/08	29 wks	3/13/09
743	RE	MTL	RE	Gift 1	Sanford	1.6.4.3.11	Reduced-Radon Air Supply to 4850L - Construction (G1)	744	3/15/10	26 wks	9/10/10
744	RE	MTL	RE	Gift 1	Sanford	1.6.4.3.12	Upgrade Yates hoists, personnel lift, Supercage, electrical - Constr	742	3/16/09	52 wks	3/12/10
745	RE	MTL	RE	Gift 1	Sanford	1.6.4.3.13	Yates Hoist Automation - Construction (G1)	742	3/16/09	26 wks	9/11/09
746						1.6.4.3.14	Yates - Basic Rehab and Upgrades Complete	744,745	3/12/10	0 wks	3/12/10
747	RE	MTL	RE	Gift 1	Sanford	1.6.4.3.15	Ross Hoist Automation - SCOPE OPTION (G1)	746	3/15/10	26 wks	9/10/10
748						1.6.4.3.16	Mid-Levels Re-Entry and Basic Infrastructure Rehab and Upgrades	747,743	9/10/10	0 wks	9/10/10
749						1.6.4.4	Deep Levels Re-entry and Infrastructure Rehabilitation (DUSEL Ph		5/22/09	92.8 wks	3/2/11
750	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.1	Deep Levels - Mobilization for Re entry (G3)	432,731	5/22/09	4 wks	6/19/09
751	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.2	Contractor Labor for Deep Levels Re-entry (G3)	432,731	5/25/09	52 wks	5/21/10
752	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.3	Equipment for Deep Levels Re-entry (G3)	432,731	5/25/09	52 wks	5/21/10
753	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.4	Subcontractor Operating Costs and Supplies for Deep Levels Re-e	432,731	5/25/09	52 wks	5/21/10
754	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.5	#6 Winze work and 8000 Skip pocket for Deep Levels Re-entry (G:	432,731	5/25/09	52 wks	5/21/10
755	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.6	Convert Koepe Hoist to winch in #6 Winze for Deep Levels Re-entr	750	6/22/09	4 wks	7/17/09
756	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.7	Ventilation Bulkheads at #6 Winze for Deep Levels Re-entry (G3)	750	6/22/09	26 wks	12/18/09
757	7400L	UG EXC	C	MREFC	NSF	1.6.4.4.8	4850L to 8000L Rehab Ramps & 50% level development	750,22	4/1/10	48 wks	3/2/11
758	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.9	#6 Winze Alterations - Permanent pumping set-up for operations	755	7/20/09	16 wks	11/6/09
759	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.10	4850L Rehab - Ross Shaft to #6 Winze	758	11/9/09	2 wks	11/20/09
760	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.11	4500L Rehab - Ross Shaft to #6 Winze	759	11/23/09	2 wks	12/4/09
761	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.12	4850L New Services - Ross Shaft to #6 Winze	760	12/7/09	2 wks	12/18/09
762	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.13	4850L Drift Shotcrete - Ross Shaft to #6 Winze	761	12/21/09	3 wks	1/8/10
763	RE	MTL	RE	Gift 3	Sanford	1.6.4.4.14	4850L Drift Concrete Floor - Ross Shaft to #6 Winze	762	1/11/10	3 wks	1/29/10
764						1.6.4.4.15	Deep Levels Re-entry and Infrastructure Rehab. Complete	761,762	3/2/11	0 wks	3/2/11
765						1.6.5	4850L Alterations and Upgrades		3/17/08	384.8 wks	7/29/15
766						1.6.5.1	4850L Ross Shops and Alterations for Construction Access		3/17/08	68 wks	7/3/09
767	4850L	UG EXC	AE	HL	SDSTA	1.6.5.1.1	Site Investigation and Geotechnical Analysis for Ross Shops Alter	788SF	3/17/08	6 wks	4/28/08
768	4850L	UG EXC	C	HL	SDSTA	1.6.5.1.2	Mobilization for 4850L Excavation	724	4/28/08	12 wks	7/18/08
769	4850L	UG EXC	C	HL	SDSTA	1.6.5.1.3	Excavation and Ground Support - 4850L Ross Shops	768	7/21/08	8 wks	9/12/08
770	4850L	UG EXC	C	HL	SDSTA	1.6.5.1.4	Concrete Floors - 4850L Ross Shops	769	9/15/08	6 wks	10/24/08
771	4850L	UG LABS	C	HL	SDSTA	1.6.5.1.5	Outfitting and Utilities - 4850L Ross Shops	770	10/27/08	8 wks	12/19/08
772						1.6.5.1.6	4850L Ross Shops Outfitting and Utilities Complete	771	12/19/08	0 wks	12/19/08
773						1.6.5.1.7	Equipment and Instrumentation Installation and Commissioning - R	904	1/19/09	24 wks	7/3/09
774						1.6.5.2	EIP Laboratories and Common Facilities: 4850L Davis , Sanford, ar		8/4/08	112.6 wks	9/29/10
775	4850L	UG EXC	AE	Gift 1	Sanford	1.6.5.2.1	Site Investigation and Geotechnical Analysis	776SF	8/4/08	6 wks	9/12/08



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5/3/07

Basis of Estimates for the Conceptual Design

- **Re-entry and Rehabilitation for Mining-to-Labs Conversion**
  - DYNATEC Feasibility Study (Syd De Vries, mining engineer)
- **Lab Module Excavation Estimated Costs, Schedule, and Feasibility**
  - Mark Laurenti (consultant, former Homestake mining engineer)
  - Golder Associates (mining engineering consultants)
- **Surface and U/G Laboratory Infrastructure: Parametric estimates**
  - LBNL Engineering and Facilities staff
- **Project Management, Staffing, Engineering and Design, Commissioning**
  - LBNL project experience, parametric and level-of-effort estimates
- **Facility Staffing, Operating Costs, and Risk Assessment:**
  - Homestake and SDSTA experience and derived estimates
  - Golder Associates (mining engineering consultants)
- **DUSEL Research Instrumentation and Experimental Equipment**
  - Science collaboration budgetary estimates, Scope-dependent (TBD)
- **Annual Escalation:** 3% per year; **Preliminary Contingency Analysis:** Range 15% to 30%

Methodology for Risk Management

- Continuous Risk Management process will be integral with Safety Management, Project Management, Systems Engineering, and Operations

- Initial steps have included Risk Identification and Preliminary Risk Analysis, with details presented in CDR and Appendices

- Risk planning has involved consultants and staff having a broad background and perspectives:

Consultants: Syd De Vries (Risk Identification, Basis of Estimates)
Mark Laurenti (Basis of Estimates, cost and schedule)
Mark Nelson, S.D. DENR (Environmental issues)
Golder Associates (Failure Modes and Effects Analysis)

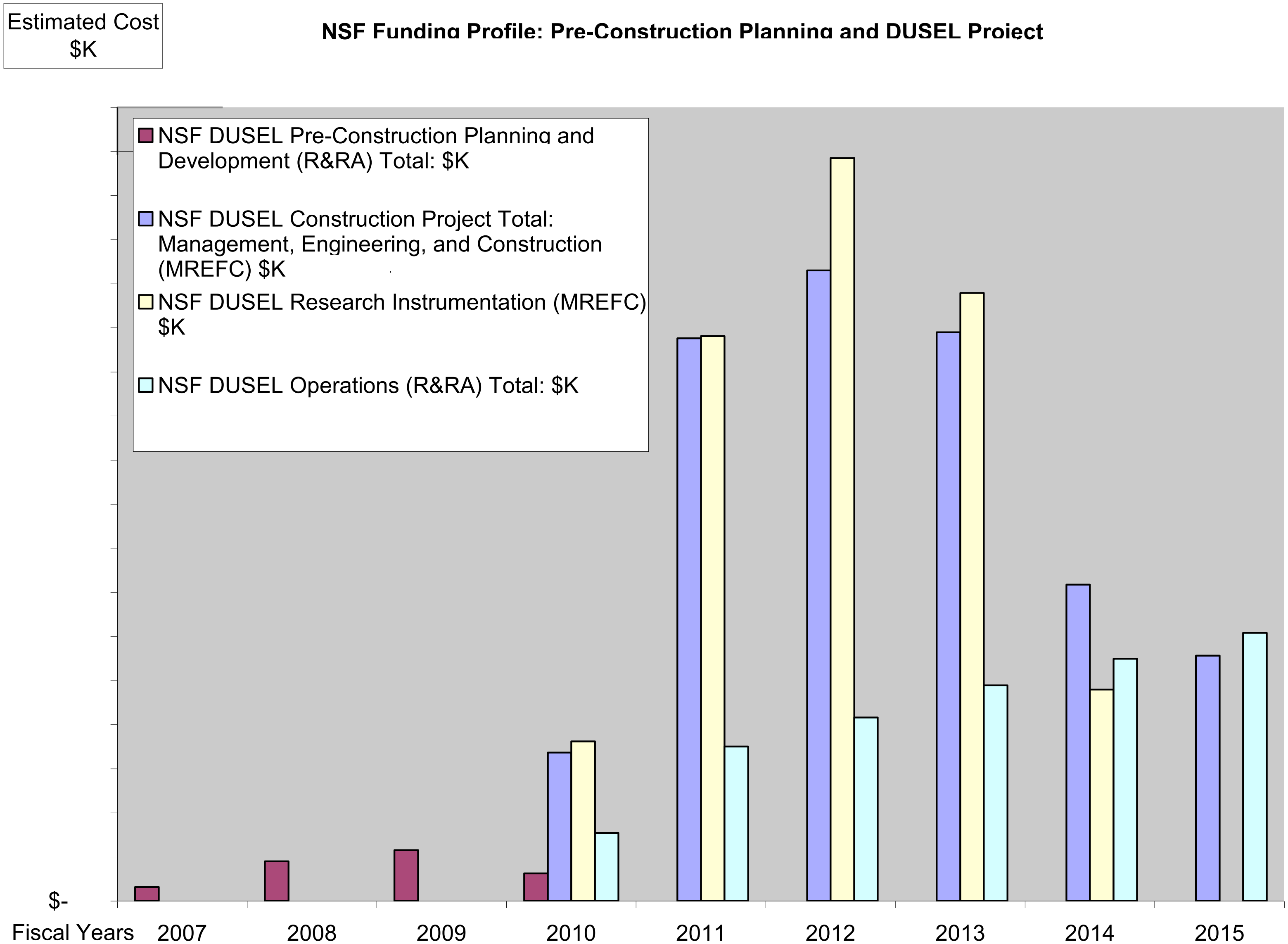
Staff and Collaborators: SDSTA Staff, notably Tom Regan (Site Conditions, Safety),
Greg King, John Marks, Gary Lillehaug (former HMC engineers)
Homestake Science Collaboration members
LBNL Management (internal review)
LBNL Project Team

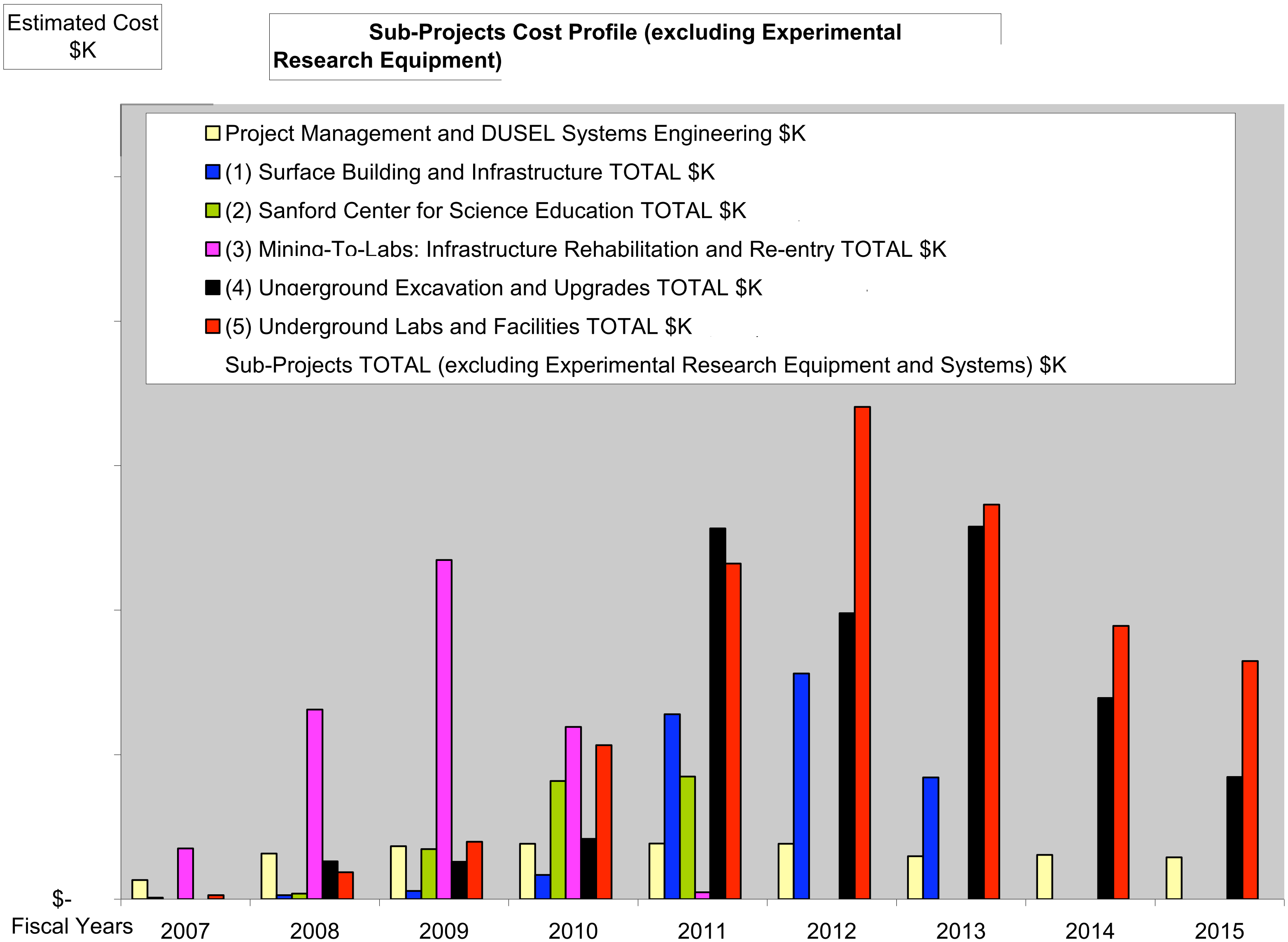
Risk Categories for Homestake DUSEL

1. Safety
2. Environmental
3. Performance and Operations
4. Project Management

High Priority and High Visibility Risk Items:

- Personnel Injury
- Water Quality, Environmental Permitting
- Infrastructure Deterioration and Rehabilitation
- Underground Fire Hazards
- Underground Rock Failure, Rock Competency
- Ponded or Stored Water Release
- Availability of Subcontractors and Equipment
- Cost and Schedule Controls, Funding Profiles


Estimated Cost $K
NSF Funding Profile: Pre-Construction Planning and DUSEL Project
NSF DUSEL Pre-Construction Planning and Development (R&RA) Total: $K
NSF DUSEL Construction Project Total: Management, Engineering, and Construction (MREFC) $K
NSF DUSEL Research Instrumentation (MREFC) $K
NSF DUSEL Operations (R&RA) Total: $K
$-
Fiscal Years
2007
2008
2009
2010
2011
2012
2013
2014
2015


Estimated Cost $K
Sub-Projects Cost Profile (excluding Experimental Research Equipment)
Project Management and DUSEL Systems Engineering $K
(1) Surface Building and Infrastructure TOTAL $K
(2) Sanford Center for Science Education TOTAL $K
(3) Mining-To-Labs: Infrastructure Rehabilitation and Re-entry TOTAL $K
(4) Underground Excavation and Upgrades TOTAL $K
(5) Underground Labs and Facilities TOTAL $K
Sub-Projects TOTAL (excluding Experimental Research Equipment and Systems) $K
$-
Fiscal Years
2007
2008
2009
2010
2011
2012
2013
2014
2015

Institutional Responsibilities and Sub-project Teams

Institution	Sub-project Teams
U.C. Berkeley, Lawrence Berkeley National Laboratory, South Dakota School of Mines and Technology and Homestake Scientifc Collaboration	Science and Engineering Research Program Development
	Environment, Health and Safety Oversight
	Education and Outreach Program Development
Lawrence Berkeley National Laboratory	Project Management and Project Controls
	Systems Engineering (requirements, risk and value management; interfaces and systems integration; validation)
	Underground Labs: Detailed engineering design and coordination with research program requirements
	Research Equipment and Experimental Instrumentation: engineering and design support
South Dakota Science and Technology Authority and South Dakota School of Mines and Technology	Environment, Health and Safety Management
	Facility Management, Site Services and Site Operations
	Mining-to-Labs Conversion: Re-entry and infrastructure rehabilitation
	Underground Labs: Construction management, commissioning, and installation of research instrumentation
	New excavation, underground facility infrastructure and services construction management, inspection, quality assurance, and commissioning

Homestake DUSEL

- Compelling Arguments for DUSEL at Homestake
  - Physical Characteristics and Key Parameters
    - Depth and Location
    - Rock
      - Well known and researched
      - Demonstrated ability to support large cavities for decades
      - Interesting and varied geology, pristine regions
  - Local, State, Regional & National Support
  - Access and Research Environment
  - Management and Operations
  - Safety Program
  - Science and Education Opportunities
  - Excellent Time and Cost to Science
    - No excavation needed to gain access to 8000
  - Reduced Risks and Uncertainties
- Deepest, Most Expedient, Extremely Cost Effective

(Semi) Unique Aspects of Homestake

- Science begins before the project begins -- gradational approach to the science
- Close interaction and cooperation with a non-academic/non-scientific entity is required
- User groups are truly multidisciplinary

References, Personnel, Other Documentation

- Michael Barnett, LBNL (E+O)
- Yuen-dat Chan, LBNL (Other uses)
- Milind Diwan, BNL (lbl, pdk)
- Reyco Henning, UNC (0vdbd, dm)
- Ken Lande, Penn (lbl, pdk, geo-neutrinos)
- Bob Lanou, Brown (neutrinos, solar neutrinos)
- Chris Laughton, FNAL (engineering)
- Kevin T. Lesko, UCB (physics) PI
- Stu Loken, LBNL (E+O)
- Hitoshi Murayama, UCB (physics theory, neutrinos)
- Tommy Phelps, ORNL (geomicro)
- Bill Roggenthen, SDSM&T (geophysics) coPI
- Ben Sayler, BHSU (E+O)
- Tom Shutt, Case Western (low backgrounds)
- Nikolai Tolich, U.W. (geonus)
- Bruce Vogelaar, Virginia Tech (solar nus)
- Herb Wang, U Wisc. (geology, rock mechanics)
- Joe Wang, LBNL (earth science, geophysics)

Richard DiGennaro, LBNL, Project Manager and Systems Engineer

Dianna Jacobs, LBNL Project Office

Dave Plate, Project Engineering

Mark Laurenti, Mining Engineer

Syd DeVries, Mining Engineer

Dave Snyder, SDSTA Exec. Director

Jose Alonso, SDSTA Lab Director

Trudy Severson, Laurie Gehner SDSTA

SDSTA Engineering and Safety Personnel

Ms. Melissa Barclay & Cathy Thompson

http://www.lbl.gov/nsd/homestake

http://neutrino.lbl.gov/Homestake/LOI

http://neutrino.lbl.gov/Homestake/FebWS

http://homestake.sdsmt.edu/HRB/Refer.htm

http://neutrino.lbl.gov/Homestake

http://www.dusel.org