Homestake DUSEL Facility Infrastructure

Richard DiGennaro

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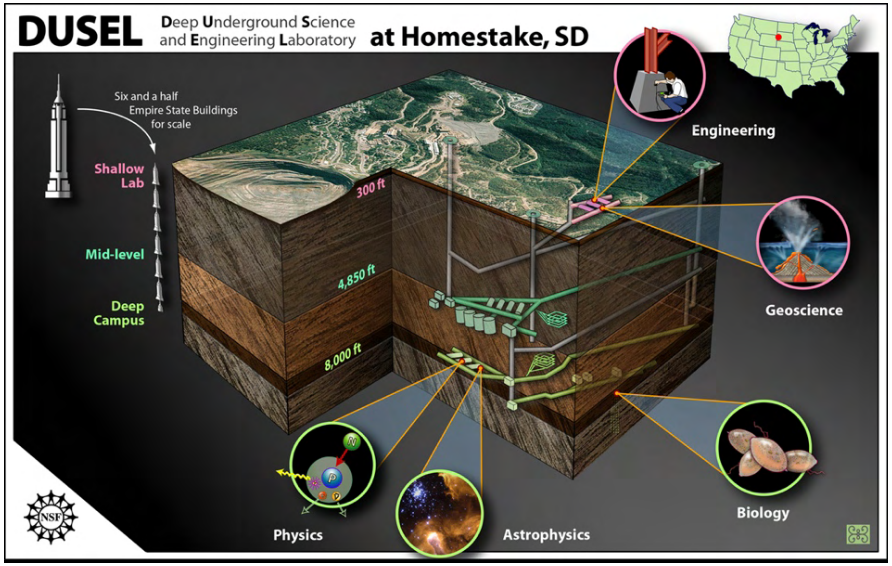


Presentation Topics:

- General Concepts for infrastructure planning at Homestake for the Initial Suite of Experiments

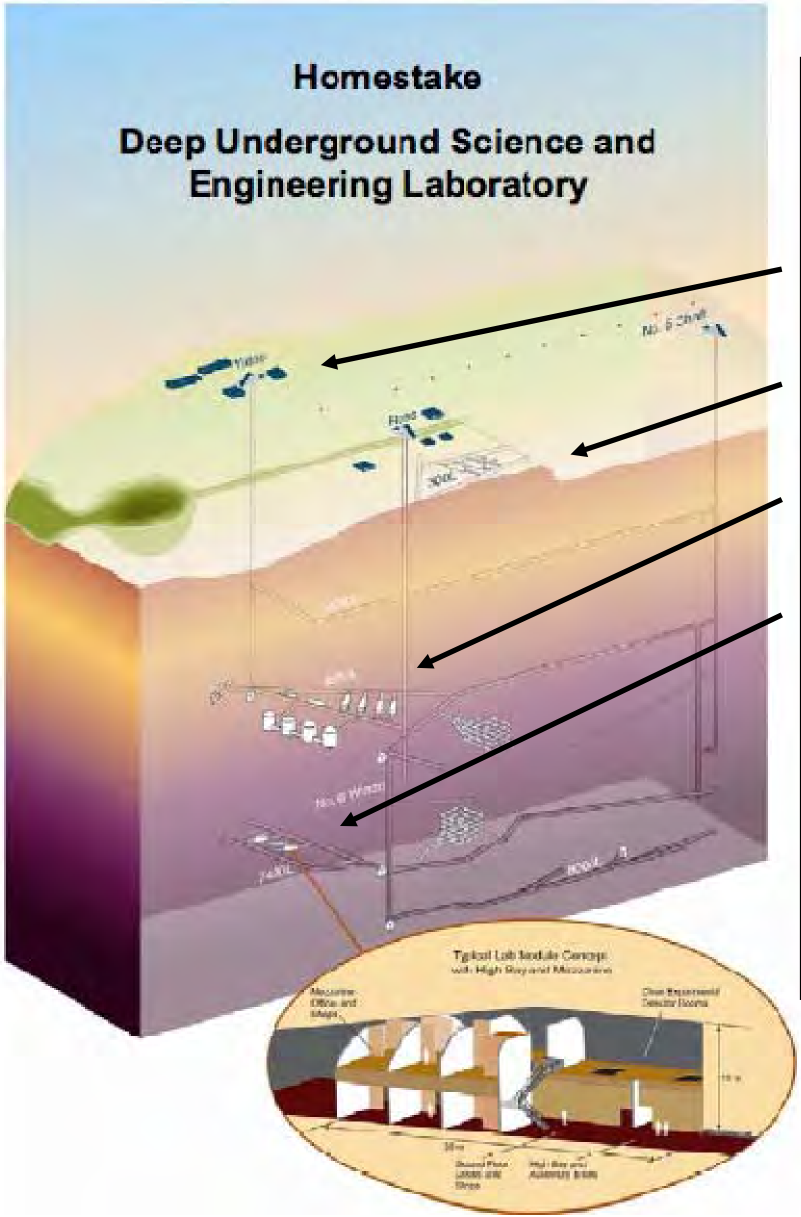
- Some examples of proposed development for Homestake DUSEL

- Overview of existing facility infrastructure

- Overview of roles and responsibilities for DUSEL Preconstruction Planning

- Systems Engineering Plans – Requirements Database

Homestake DUSEL Campus Development

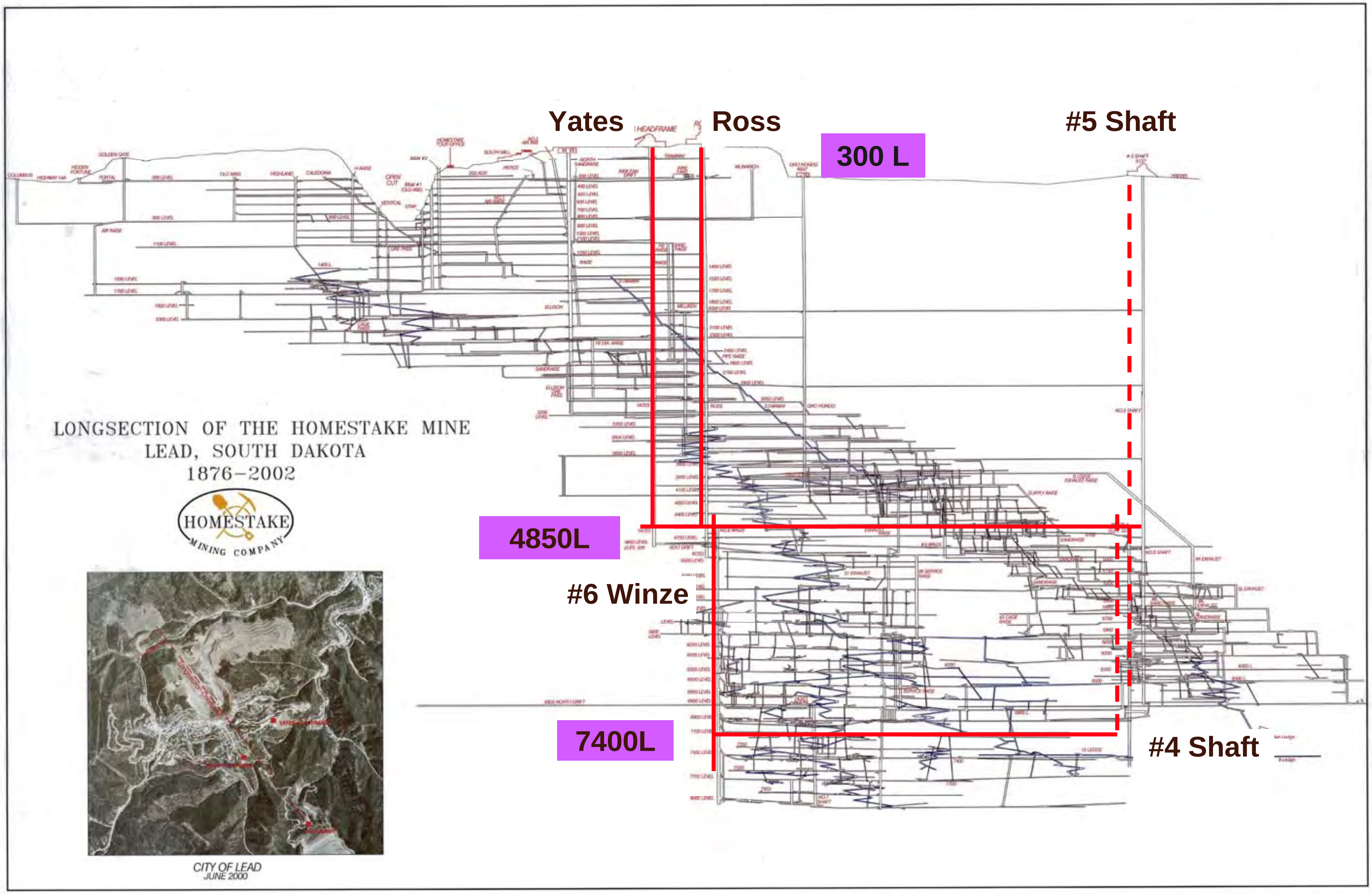


Four primary campus locations for research:

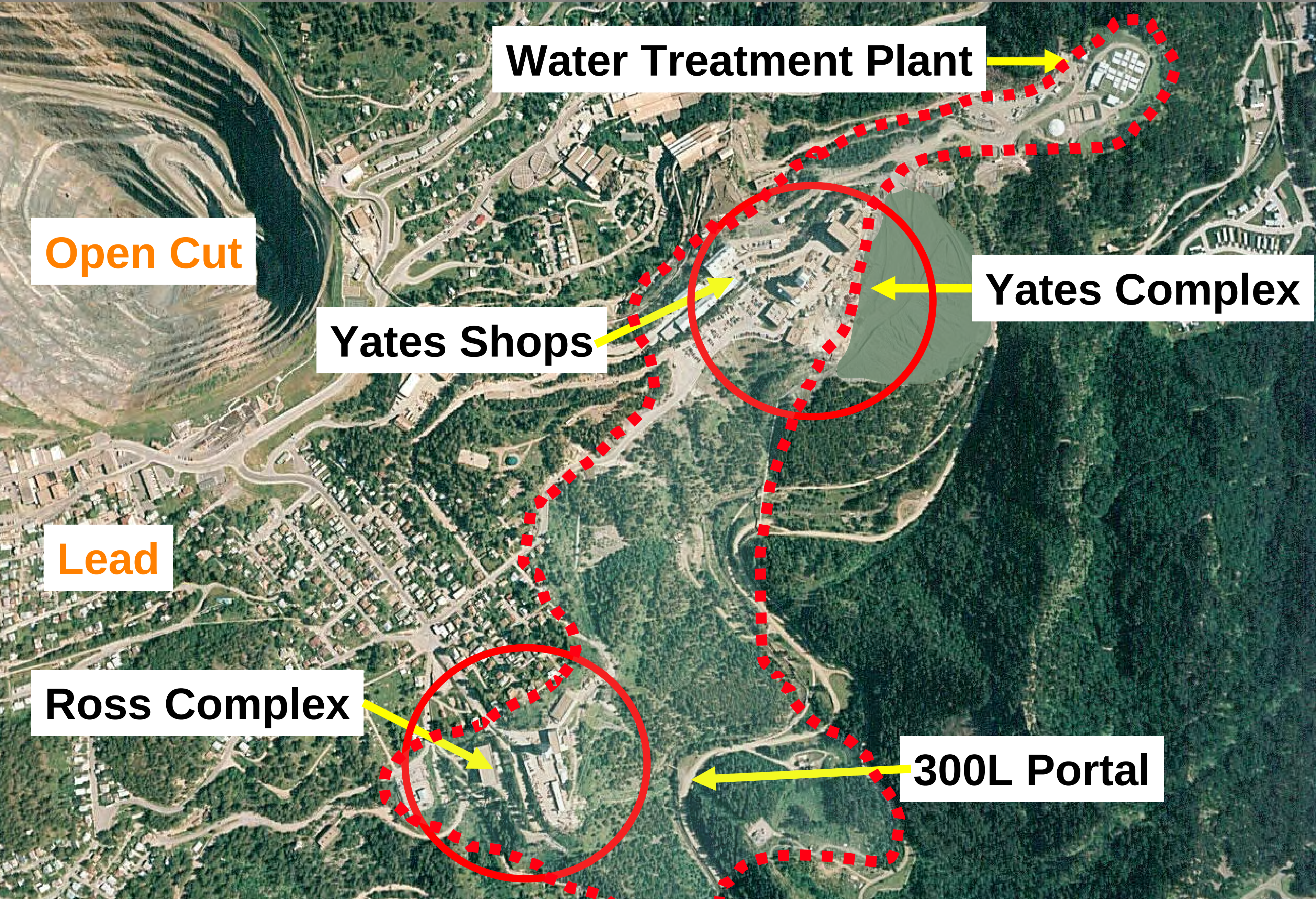
1. Surface campus at Yates Complex
2. Near-surface campus at 300 Level
3. Mid-level campus at 4850 Level
4. Deep-level campus at 7400 Level

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.

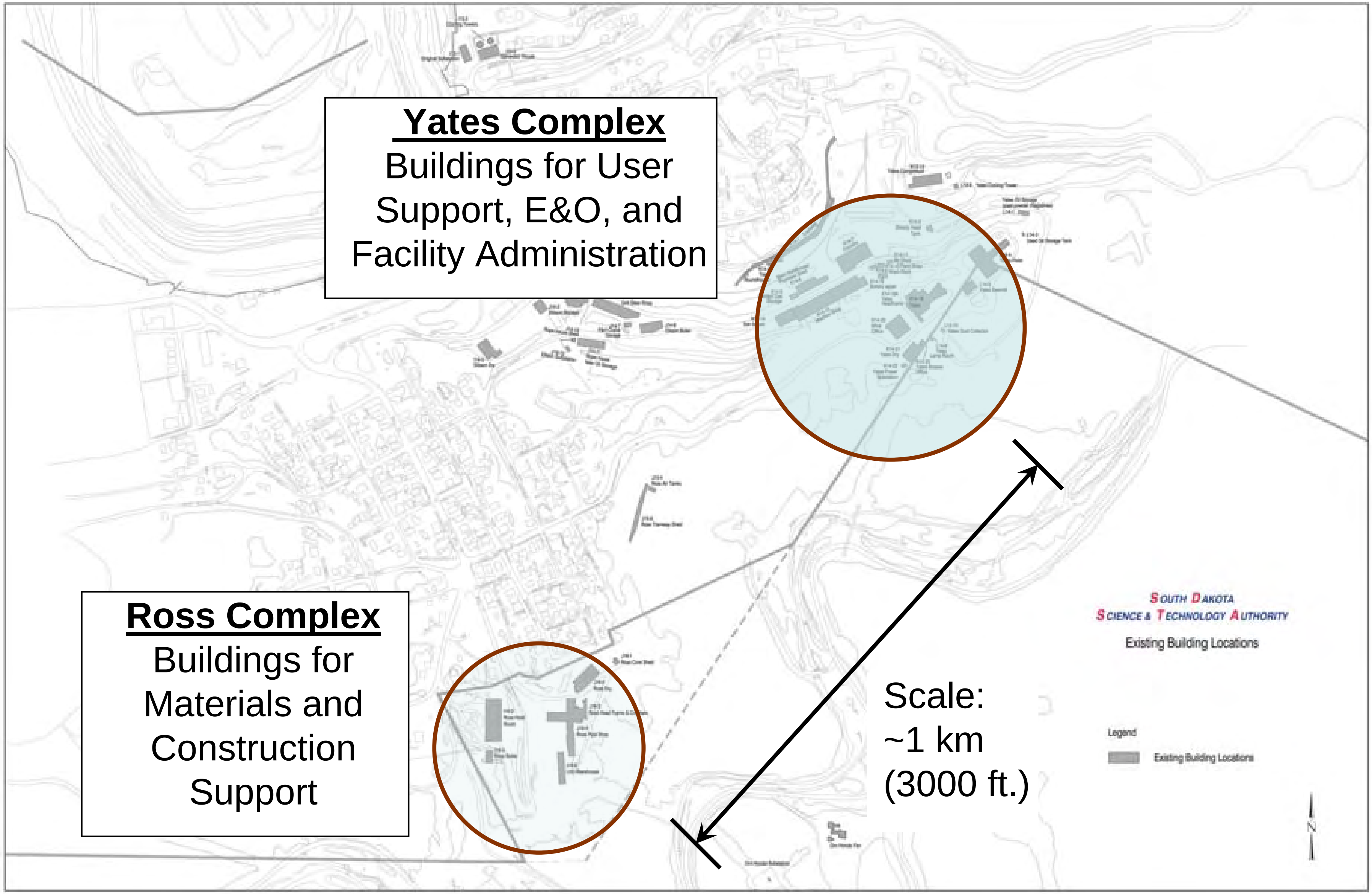
Homestake Long Section



Homestake and Lead Aerial Photo

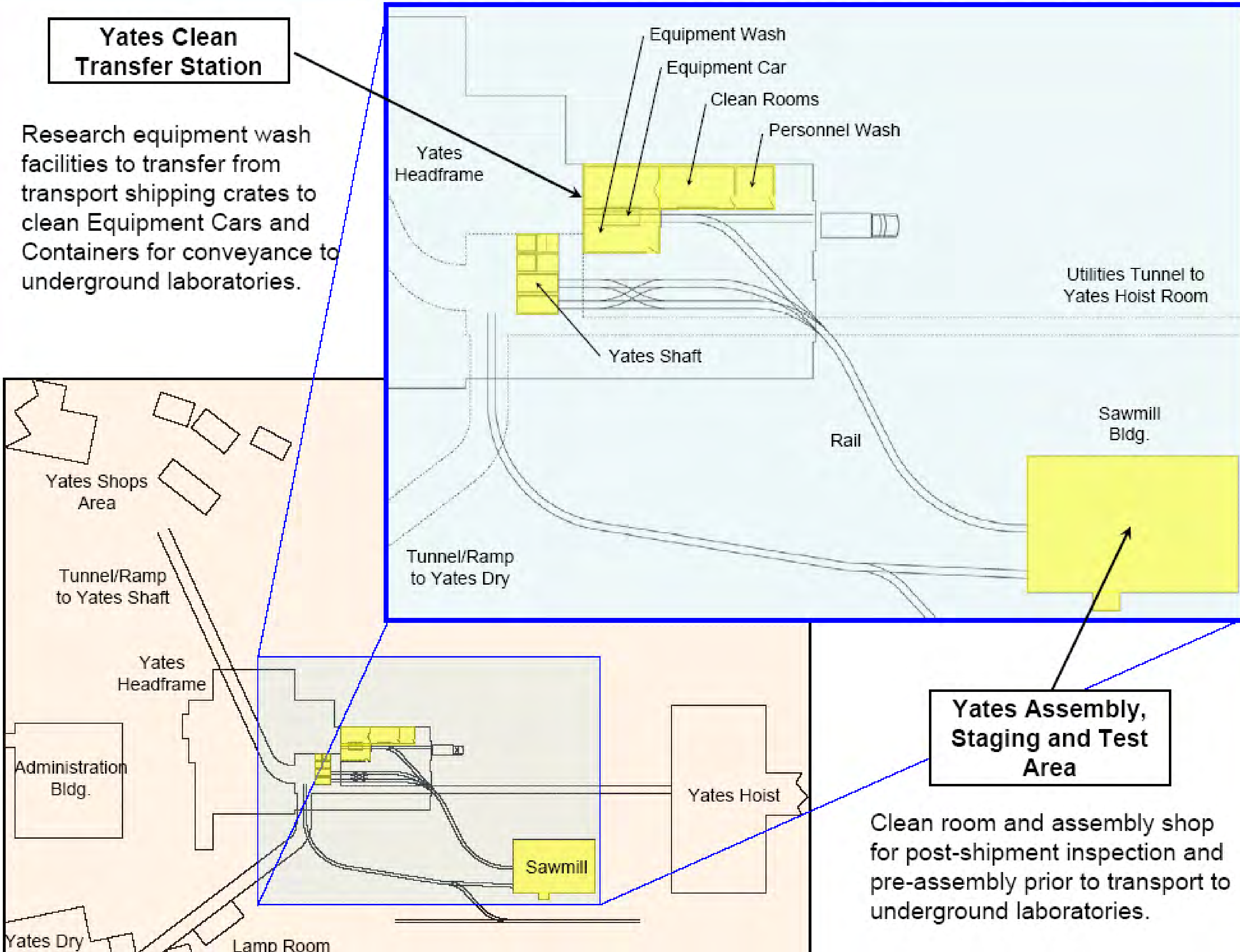


Surface Campus Development Plan



Yates Clean Transfer Station

Research equipment wash facilities to transfer from transport shipping crates to clean Equipment Cars and Containers for conveyance to underground laboratories.



Yates Assembly, Staging and Test Area

Clean room and assembly shop for post-shipment inspection and pre-assembly prior to transport to underground laboratories.

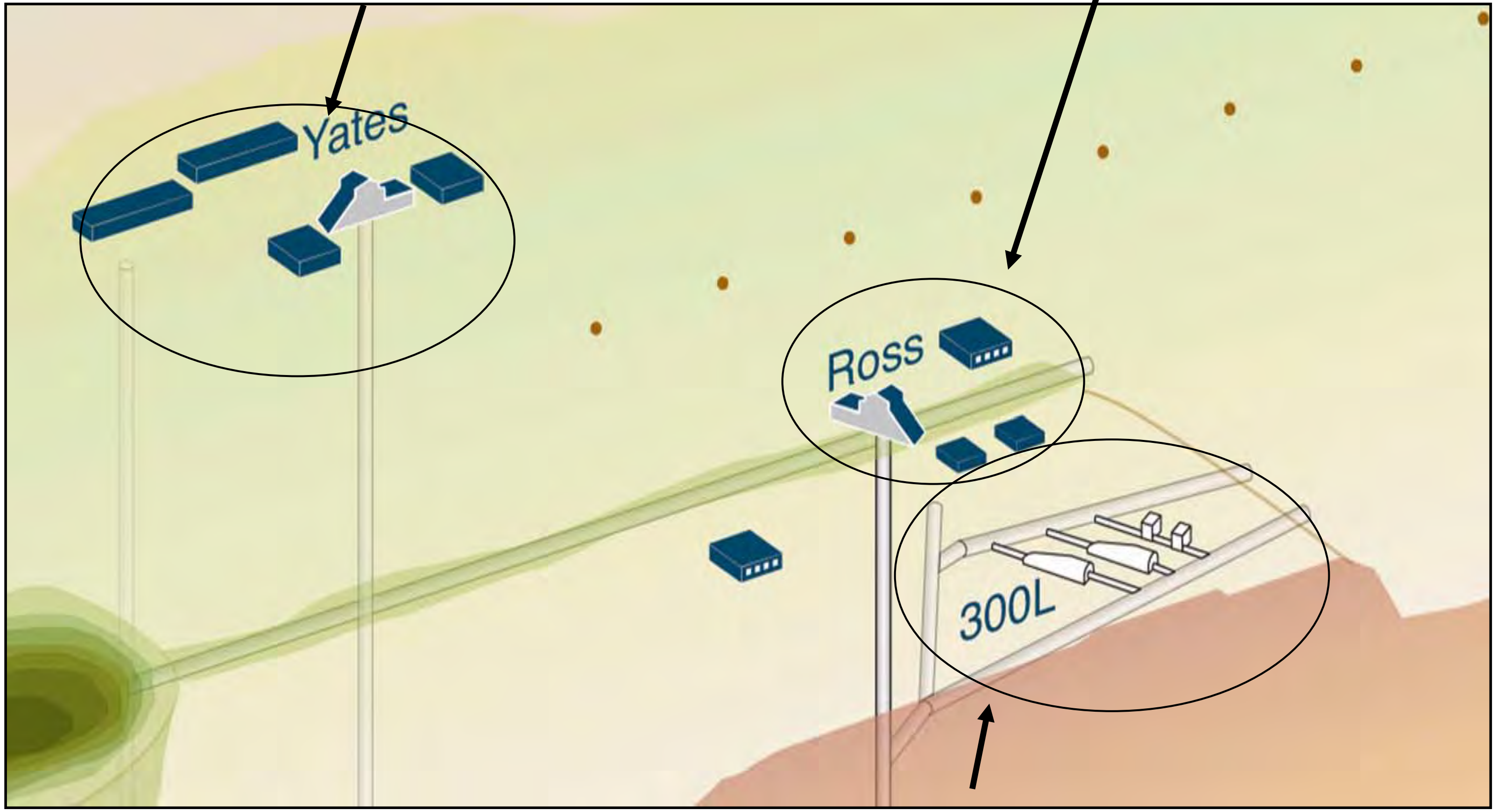
Partial List - SDSTA Building Inventory

SDSTA Building Inventory							12/1/2004
Description	Group	Type of Renovation	Building Footprint			Number of Usable/Accessible Floors	Total Floor Area (sq. ft.)
			Length (ft.)	Width (ft.)	Area (sq. ft.)		
Yates Sawmill	Yates	Alterations and Upgrades for DUSEL	68	44	2,992	1	2,992
Yates Safety and Dry	Yates	Alterations and Upgrades for DUSEL	Irregular		5,883	3	17,649
Yates Ramp and Lamp Room	Yates	Alterations and Upgrades for DUSEL	24	22	528	1	528
Yates Hoist and MG Set Rooms	Yates	Alterations and Upgrades for DUSEL	Irregular		16,130	1	16,130
Yates Headframe Bldg.	Yates	Alterations and Upgrades for DUSEL	Irregular		16,679	1	16,679
Yates Bosses Office	Yates	Alterations and Upgrades for DUSEL	26	22	572	1	572
Administration Office	Yates	Alterations and Upgrades for DUSEL	88	93	8,184	2	16,368
Shovel and Battery Repair Shop	Shops	Alterations and Upgrades for DUSEL	48	23	1,104	1	1,104
Paint Shop	Shops	Alterations and Upgrades for DUSEL	34	21	714	1	714
Main Warehouse and Plumbers Shed	Shops	Alterations and Upgrades for DUSEL	Irregular		6,393	4	25,572
Machine and Metal Fab Shop	Shops	Alterations and Upgrades for DUSEL	Irregular		25,036	1	25,036
Iron House	Shops	Alterations and Upgrades for DUSEL	98	55	5,390	1	5,390
Foundry	Shops	Alterations and Upgrades for DUSEL	Irregular		13,710	1	13,710
Bit Shop and Shop Yard	Shops	Alterations and Upgrades for DUSEL	30	15	450	1	450
		Alterations and Upgrades for DUSEL Total					**142,894**

Surface Facilities and
Near-surface campus at 300 Level

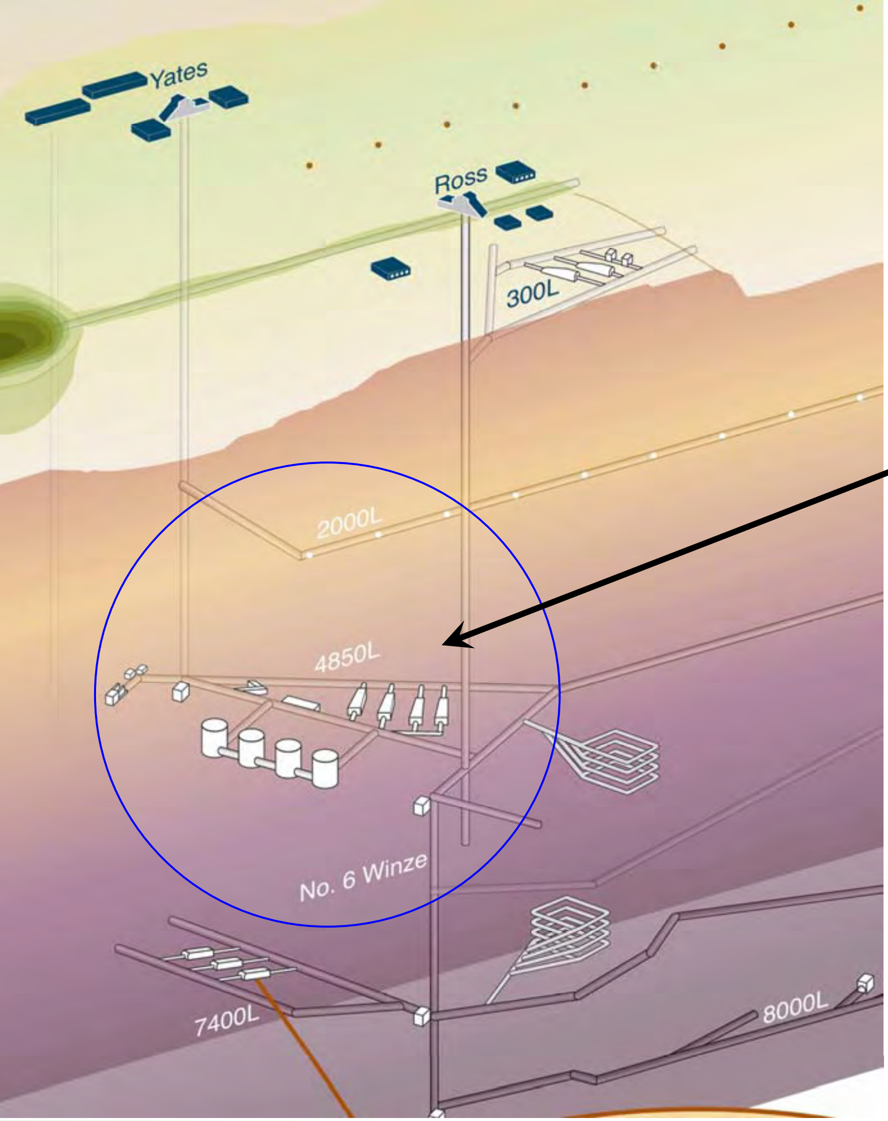
Over 100,000 ft^2 of existing space at the Yates Complex may be used for User Activities and Facility Management

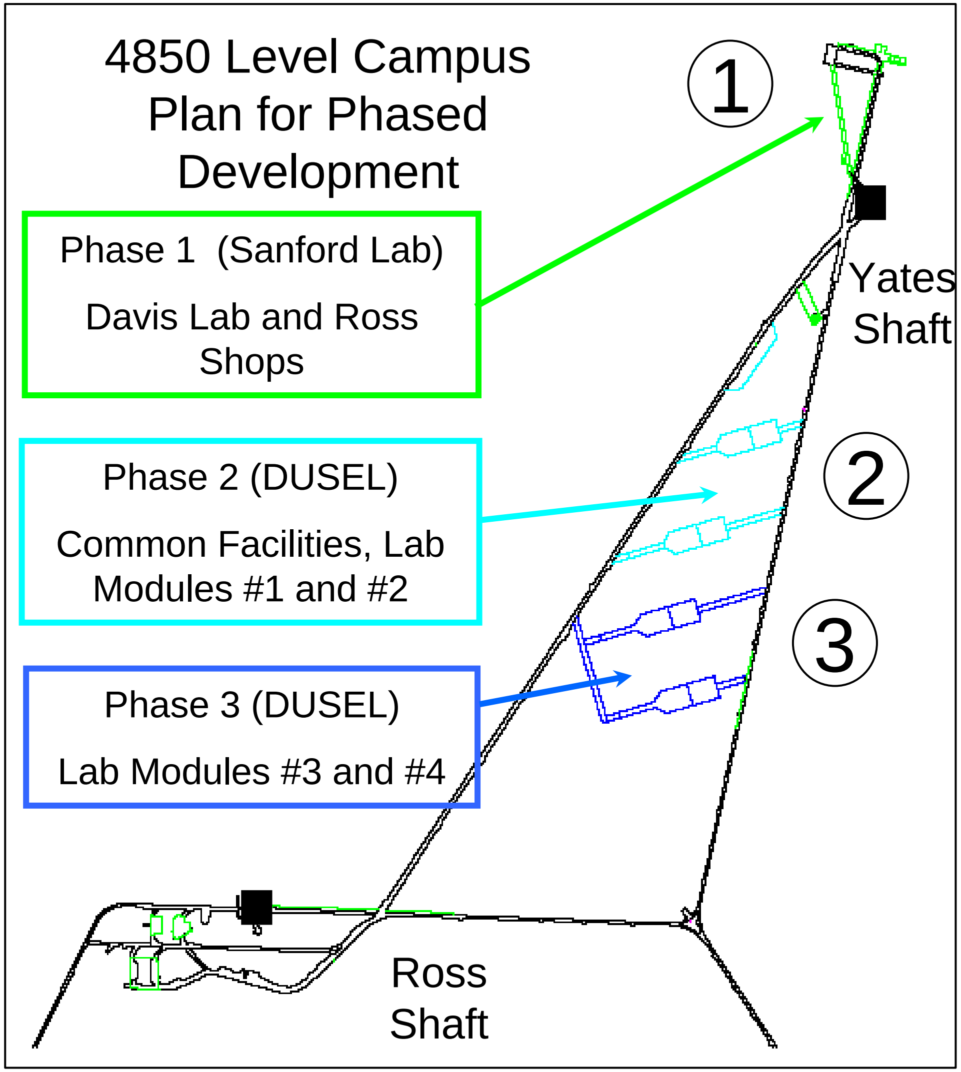
Existing space at the Ross Complex may be used for construction, maintenance, and site services.



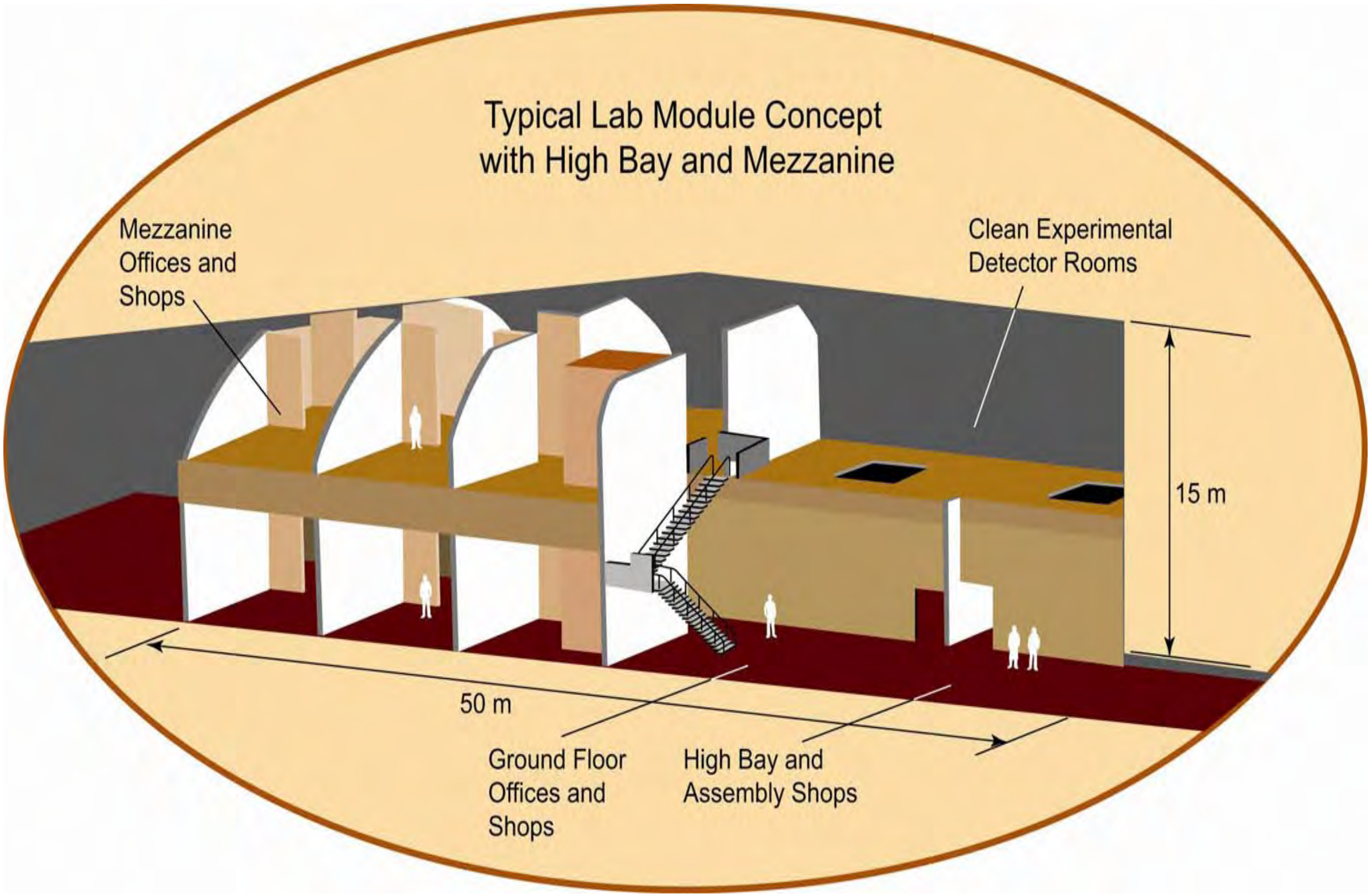
The Near-surface Campus at 300L can provide drive-in access to material and fabrication shops, rooms for Education and Outreach, and R&D laboratories.

Campus Development Concepts at 4850 Level



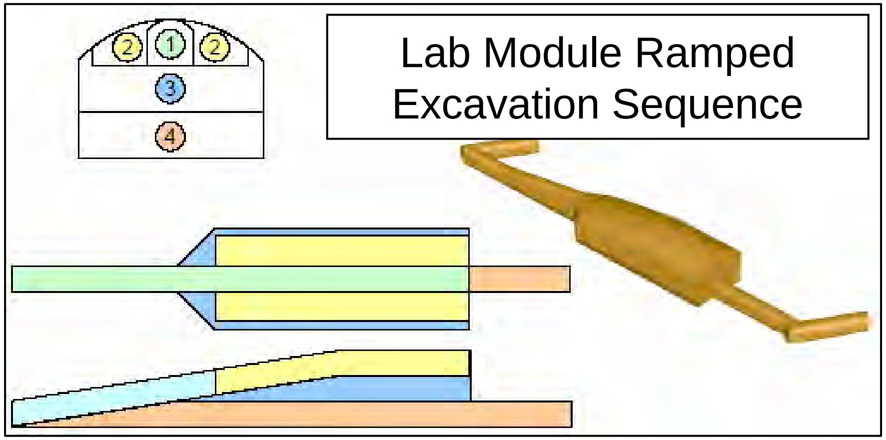


Lab Module Concept for Analysis and Feasibility Studies

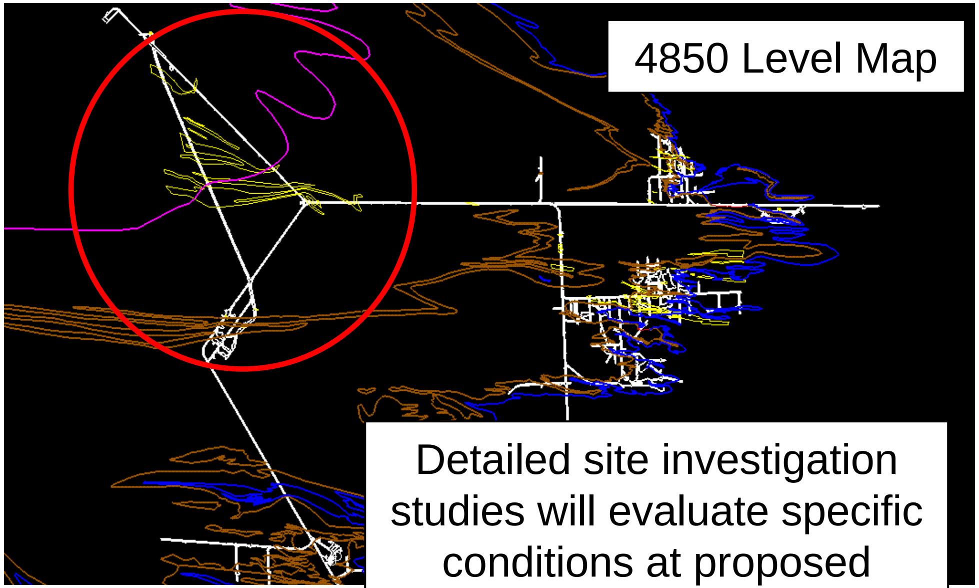


Purpose-built laboratories modules and infrastructure will be developed to match specific experimental requirements.

Preliminary Feasibility Studies for Excavation and Ground Support for Typical Lab Modules



FORMATION	LEVEL	LOCATION	BOLTING	SHOTCRETE
Poorman Formation	4850L	Roof	5 m long bolts @ 2 m c/c	90 mm fibre reinforced shotcrete
		Side Walls	8 m long bolts @ 1.75 m c/c	100 mm unreinforced shotcrete
	7400L/8000L	Roof	5 m long bolts @ 1.75 m c/c	100 mm fibre reinforced shotcrete
		Side Walls	8 m long bolts @ 1.5 m c/c	90 mm fibre reinforced shotcrete
Yates Unit	4850L	Roof	5 m long spot bolts	none
		Side Walls	4 m long bolts @ 2.5 m c/c	none
	7400L/8000L	Roof	5 m long bolts @ 2.5 m c/c	none
		Side Walls	4 m long bolts @ 2.25 m c/c	50 mm unreinforced shotcrete

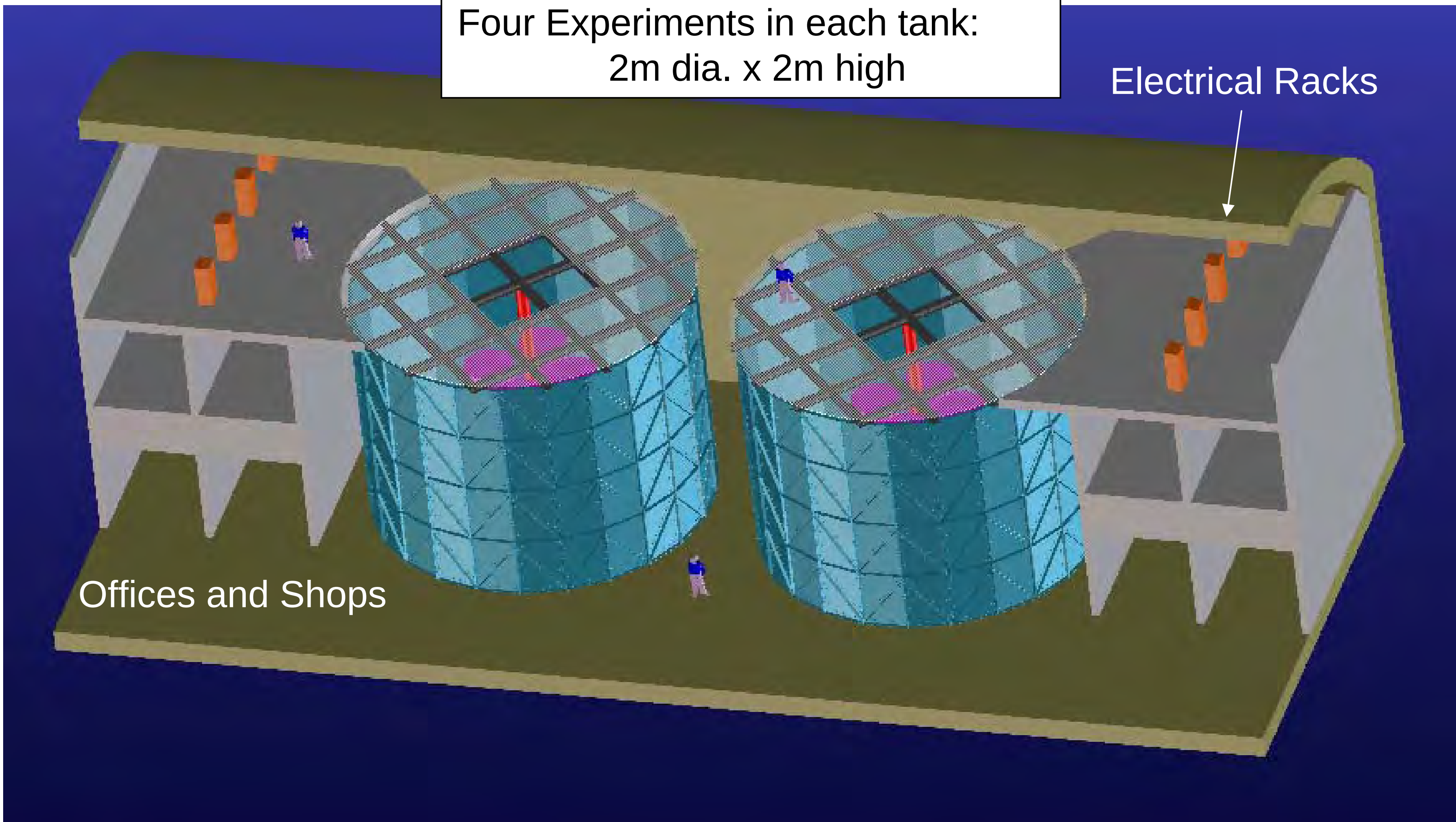


Detailed site investigation studies will evaluate specific conditions at proposed locations for development.

Preliminary Geotechnical Analyses were done to support the site selection and identify preliminary requirements for excavation and ground support requirements.

Water Shield Facility Concept for Multiple Experiments

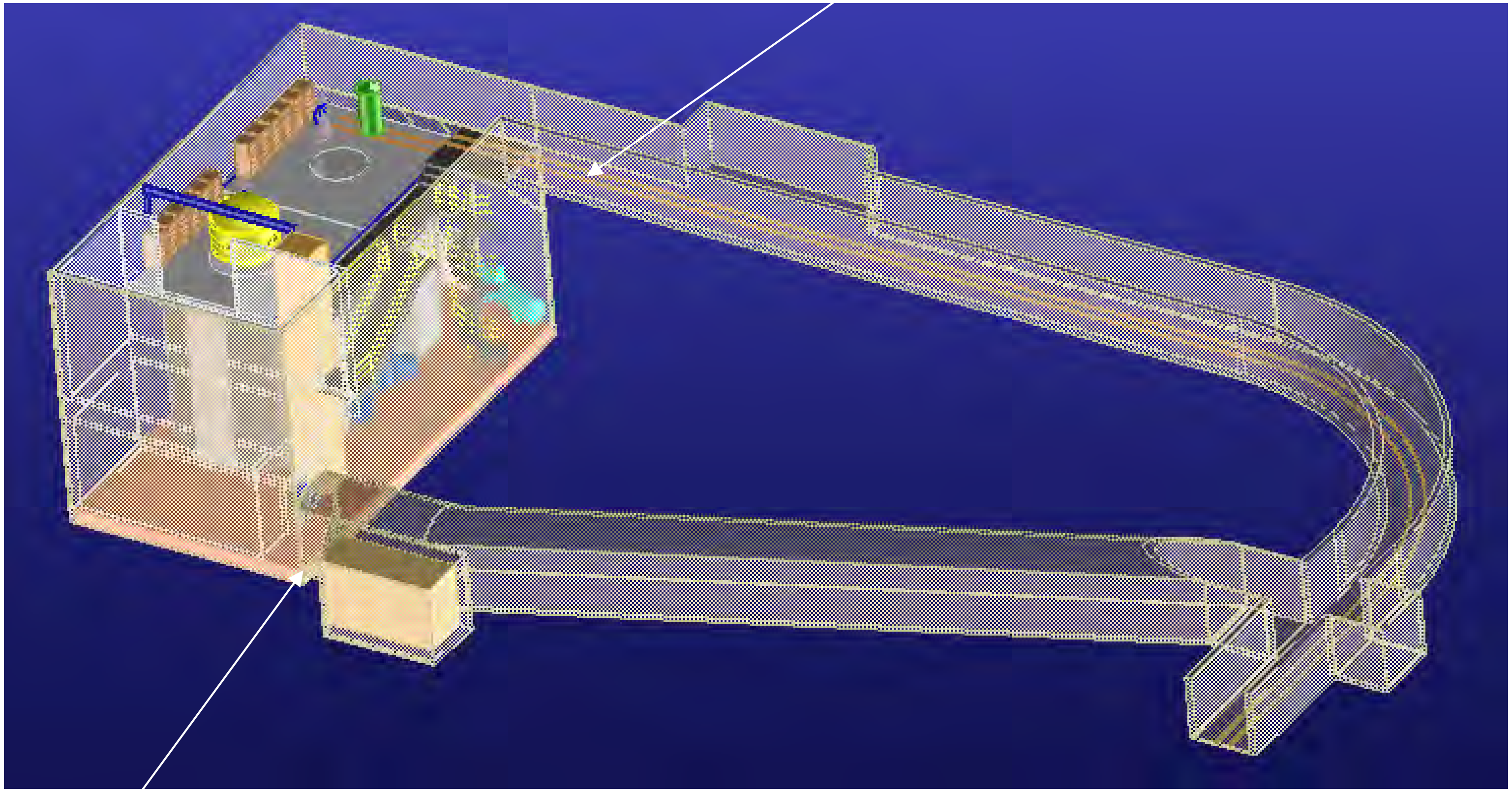
Two Water Tanks:
14m dia. x 10m high
Four Experiments in each tank:
2m dia. x 2m high



Feasibility Studies to consider using the existing Davis Lab for early experiments:

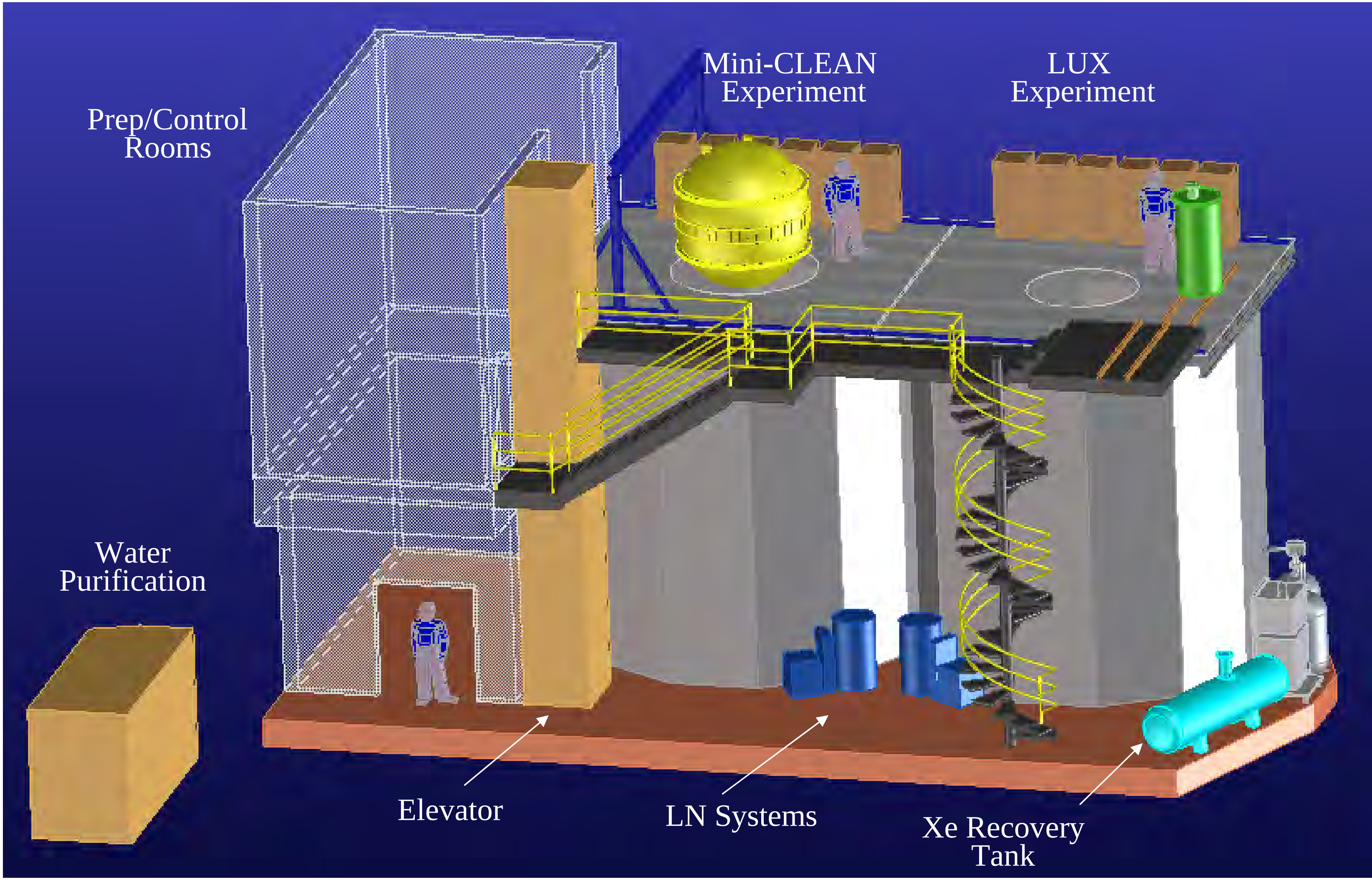
Current Davis Cavity Dimensions:
55ft x 30ft x 32ft high

4850L Access

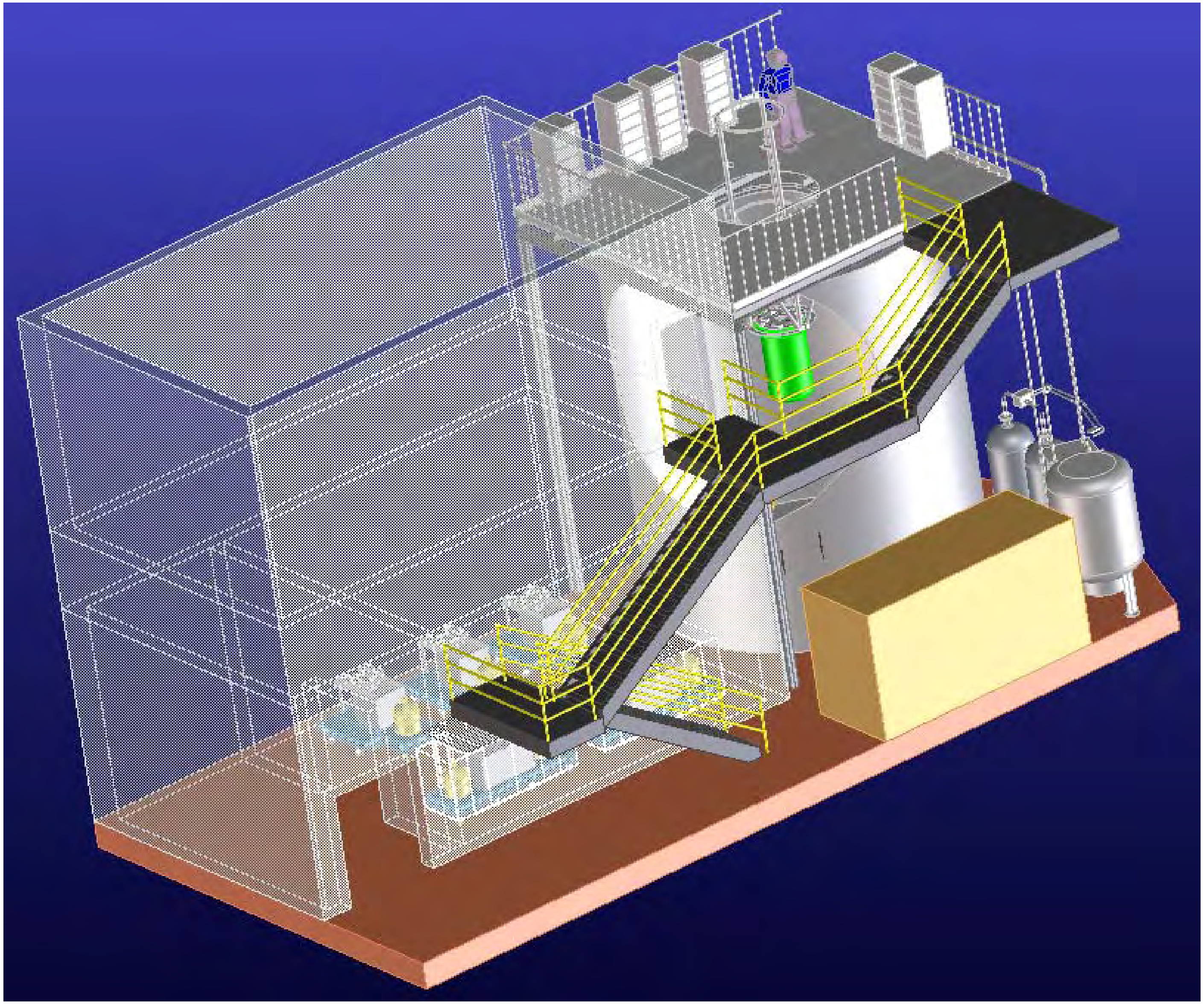


4874L Secondary Access

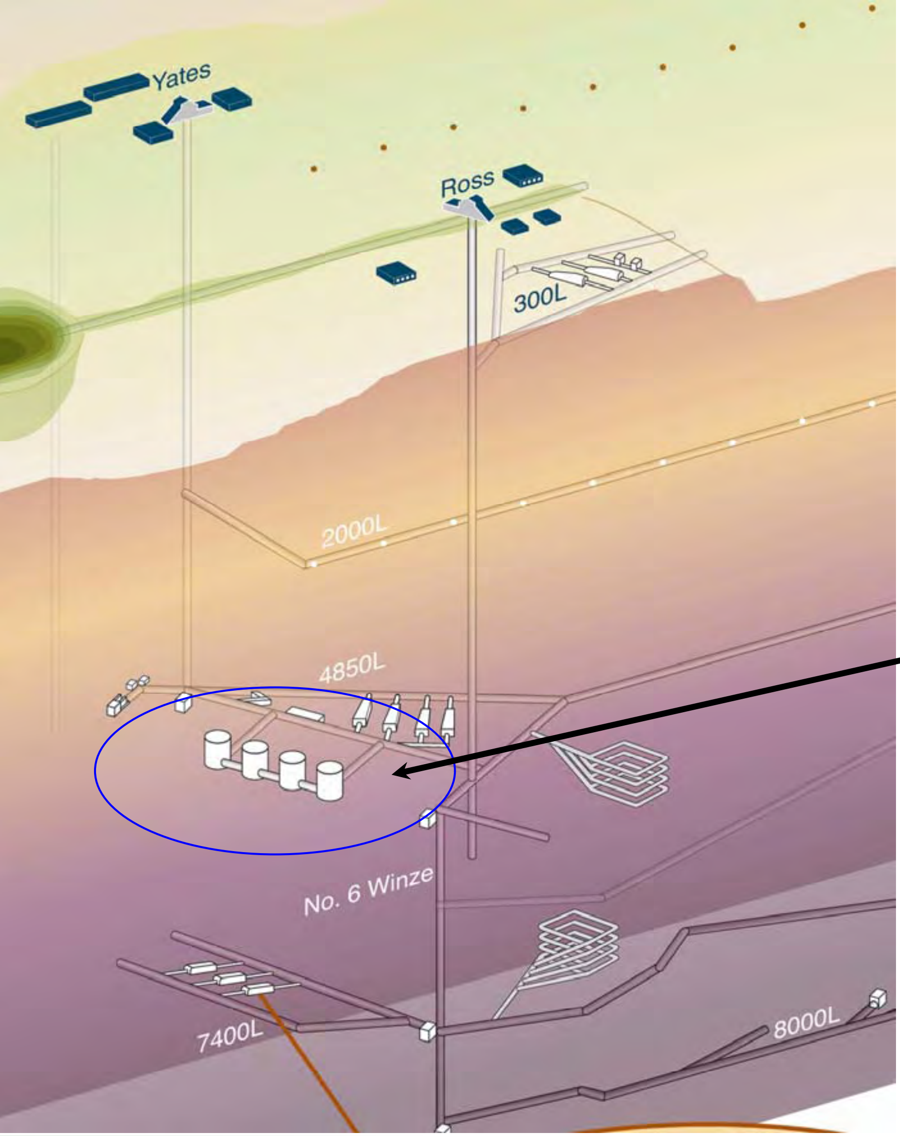
Davis Lab with proposed LUX and Mini-CLEAN Experiments



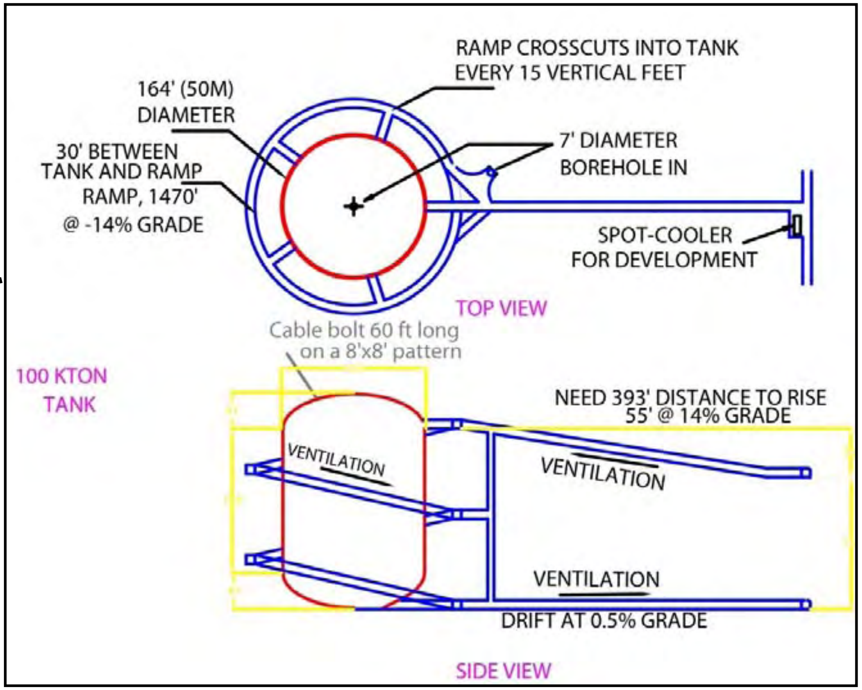
Davis Lab alternate configuration with LUX experiment and Low Background Facility



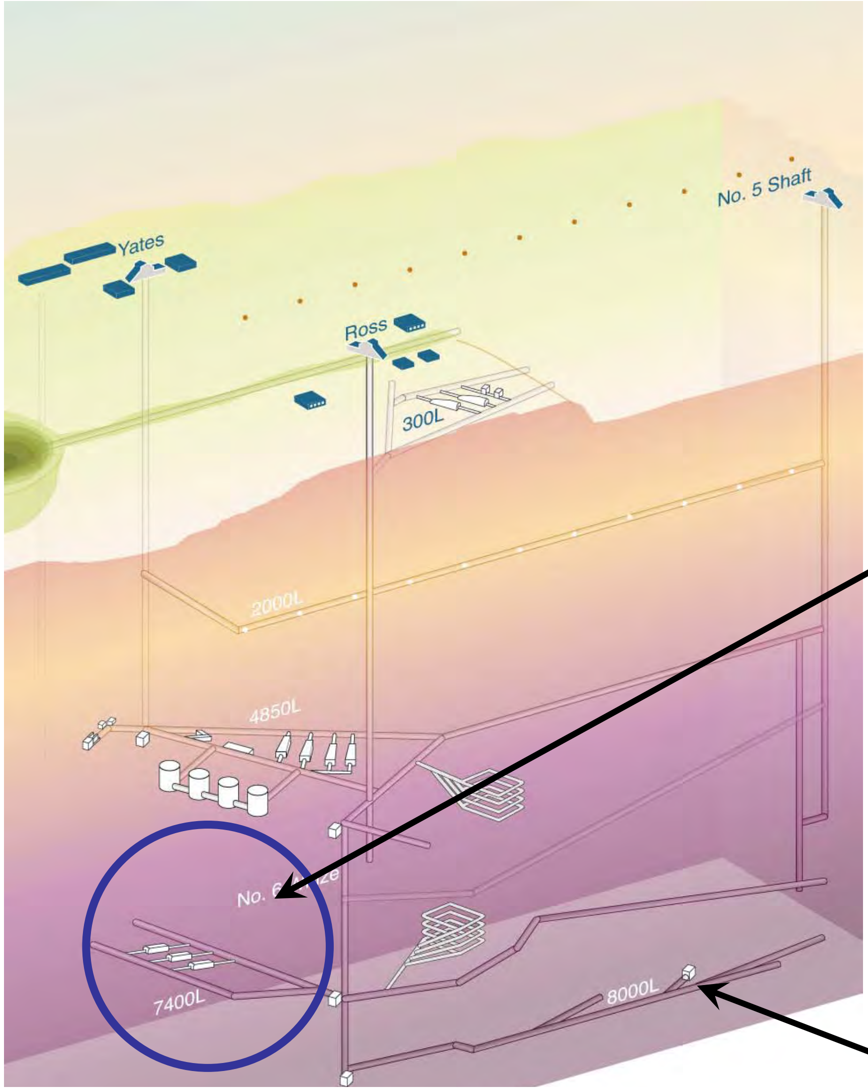
Concept studies for large cavity construction



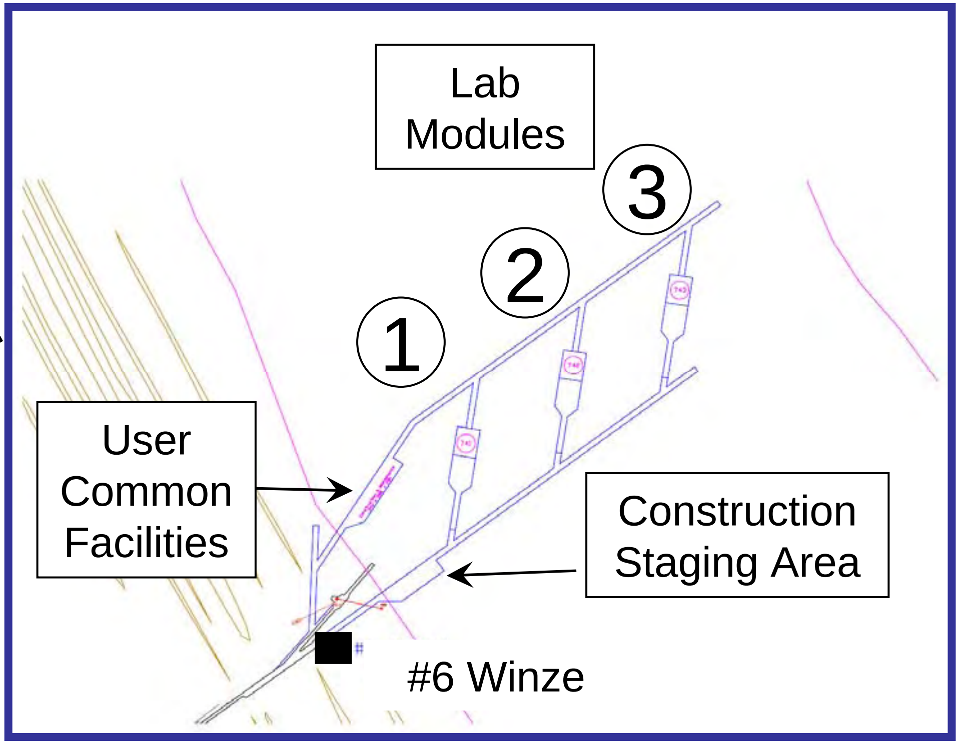
Concept studies and preliminary geotechnical analyses have demonstrated that large cavities of ~50 m diameter and 100 m height are feasible at 4850 Level and deeper.



Deep Campus at 7400 Level and access to additional ramps and drifts down to 8000 Level



Phased development of purpose-built lab modules at 7400L will enable concurrent research operations with on-going excavation and construction.



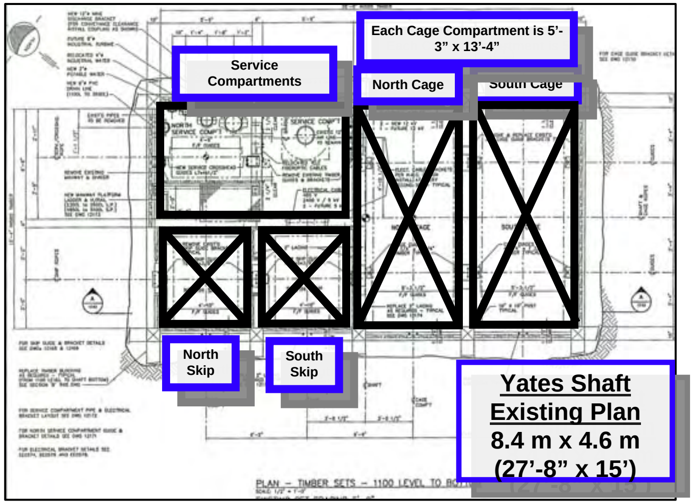
Access to other levels will enable unique or exploratory research, including the existing Drilling Room at the 8000 Level

Proposed Surface and Underground Development Program

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)	
	sq. ft.	sq. m.	cu. yd.	cu. m.
4850 Level Subtotal	**107,351**	**9,973**	**111,115**	**84,903**
Ross Shops for Construction Staging	12,469	1,158	5,738	4,385
Davis Lab, Sanford Lab, and Bio-Geo Lab	15,738	1,462	13,543	10,348
Lab Module #1 and Common Facilities	26,464	2,459	25,155	19,221
Lab Module #2	17,560	1,631	21,433	16,377
Lab Module #3	17,560	1,631	23,121	17,667
Lab Module #4 (excavation only, without lab outfitting)	17,560	1,631	22,125	16,906
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
Lab Modules #2 and #3 (excavation only, without lab outfitting)	35,120	3,263	68,883	52,633
300 Level Subtotal	**8,668**	**805**	**14,007**	**10,703**
Lab #1, Shops, and E&O Rooms	8,668	805	14,007	10,703
Surface Subtotal	**98,000**	**9,104**		
DUSEL Offices and User Support Areas,Phase 1	10,000	929		
Sanford Clean Room and Assembly Shop	6,000	557		
DUSEL Offices and User Support Areas,Phase 2	32,000	2,973		
Sanford Center for Science Education	50,000	4,645		
Total	**277,607**	**25,790**	**223,599**	**170,852**

Yates Shaft Upgrade Plan

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



Existing Cage Dimensions and Capacities

Yates Cage Hoist

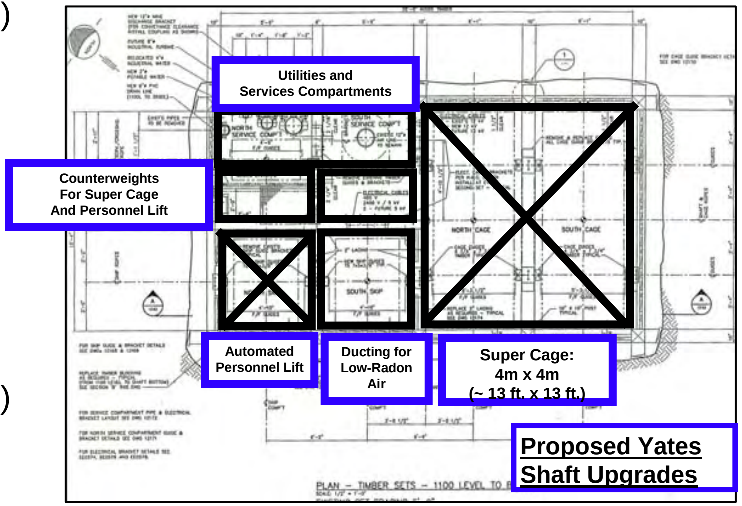
Maximum cage dimensions:	1.4 x 3.7 x 2.2m high (side-by-side) (4' 8" x 12' 1.5" x 7' 2" high)
Maximum cage payload:	5,450 kg (12,000 lb), nominal 5,900 kg (13,000 lb), at 1/2-speed.

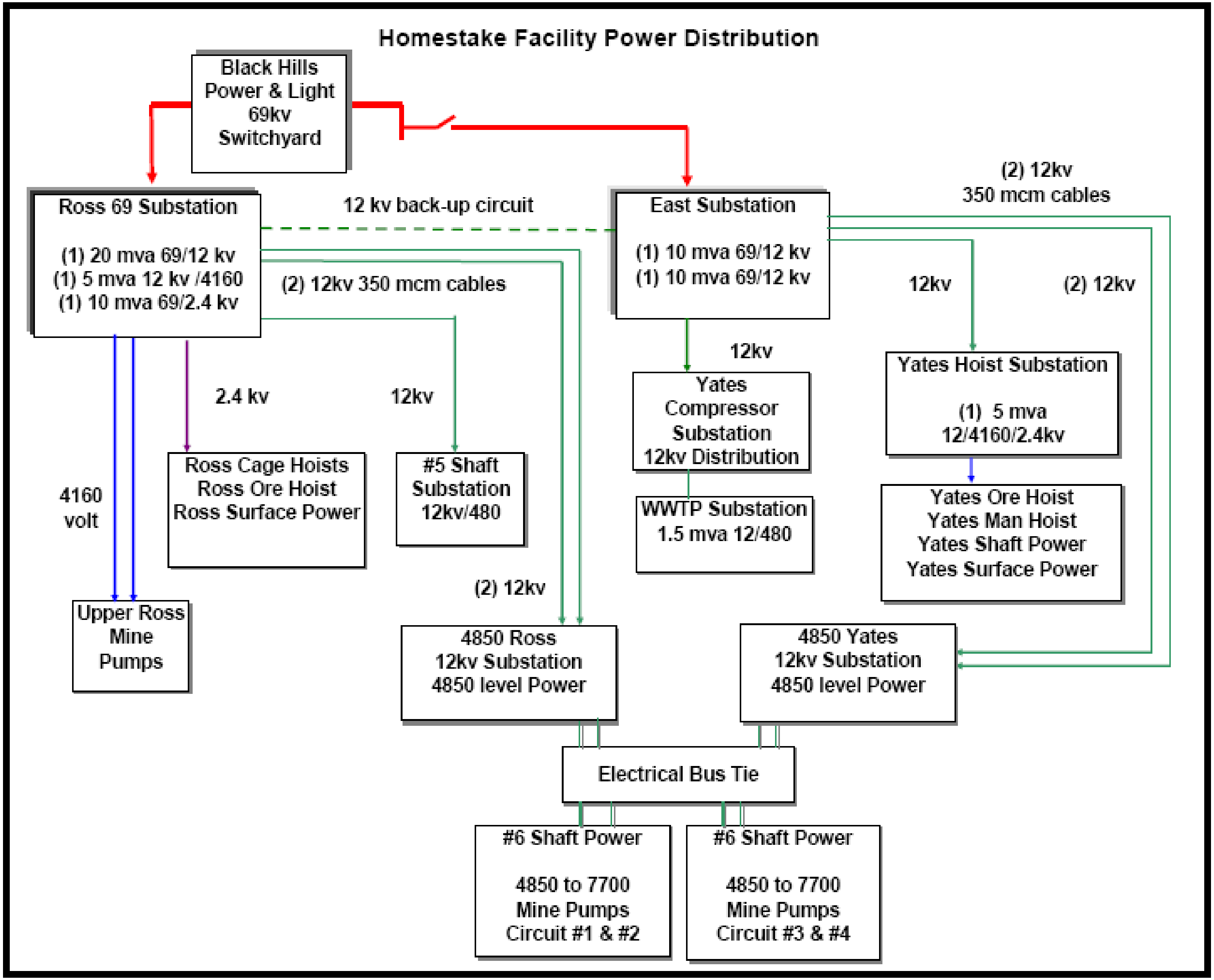
Ross Cage Hoist

Maximum cage dimensions:	1.3 x 3.8 x 2.2m high (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), at 1/2-speed.

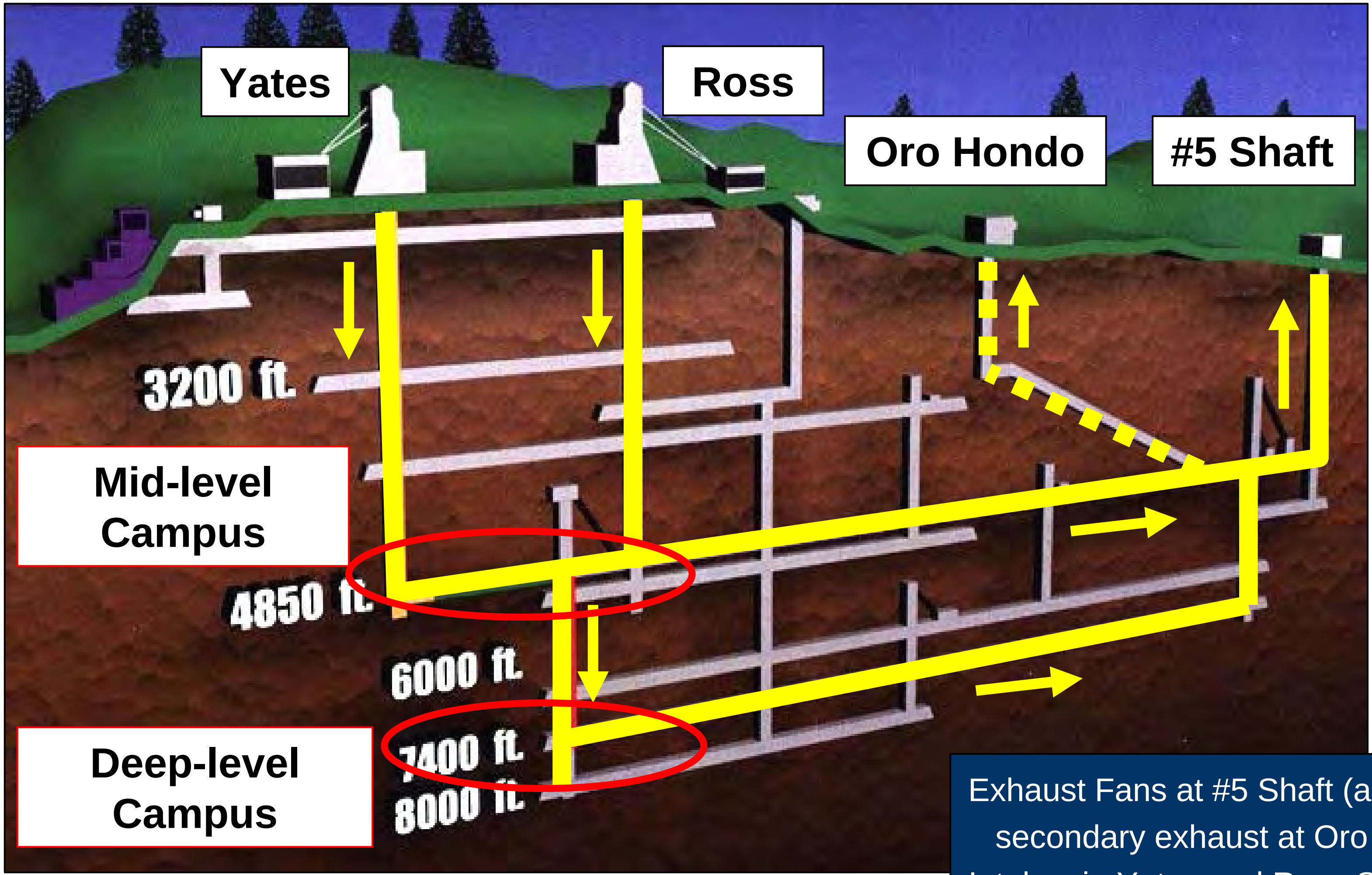
#6 Winze Cage Hoist

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), at 1/2-speed.




Homestake Facility Power Distribution
Black Hills Power & Light 69kv Switchyard
Ross 69 Substation
(1) 20 mva 69/12 kv
(1) 5 mva 12 kv /4160
(1) 10 mva 69/2.4 kv
12 kv back-up circuit
East Substation
(1) 10 mva 69/12 kv
(1) 10 mva 69/12 kv
(2) 12kv
350 mcm cables
(2) 12kv 350 mcm cables
12kv
(2) 12kv
12kv
Yates Compressor Substation 12kv Distribution
Yates Hoist Substation
(1) 5 mva
12/4160/2.4kv
2.4 kv
12kv
Ross Cage Hoists
Ross Ore Hoist
Ross Surface Power
#5 Shaft Substation 12kv/480
WWTP Substation 1.5 mva 12/480
Yates Ore Hoist
Yates Man Hoist
Yates Shaft Power
Yates Surface Power
4160 volt
Upper Ross Mine Pumps
(2) 12kv
4850 Ross 12kv Substation 4850 level Power
4850 Yates 12kv Substation 4850 level Power
Electrical Bus Tie
#6 Shaft Power
4850 to 7700 Mine Pumps Circuit #1 & #2
#6 Shaft Power
4850 to 7700 Mine Pumps Circuit #3 & #4

General Plan for Primary Ventilation



Exhaust Fans at #5 Shaft (alternate or secondary exhaust at Oro Hondo)
Intake via Yates and Ross Shafts

Proposed R&D for Infrastructure Development

- **Hazardous Materials Transport, Storage, Operations**

  (e.g., Large volumes of cryogens)

- **Clean Transport Containers and Handling Systems (similar to SNOLab configurations)**

  (Standard sizes, capacities, "Double-bagged", clean room transitions, rigging and lifting fixtures, etc.)

- **Large-scale Reduced-radon Air Supply**

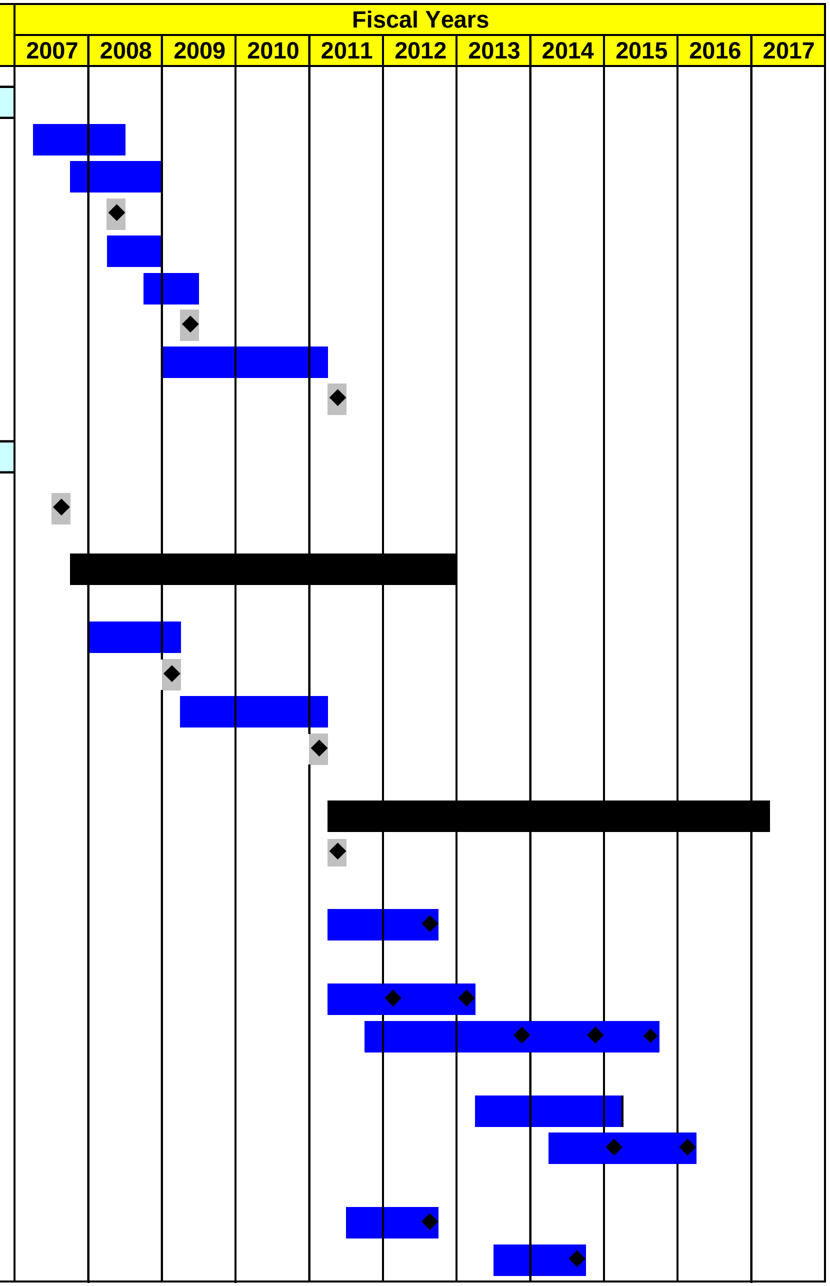
- **Large-scale Underground Clean Rooms and Clean Transitions**

- **Large-scale Purified Water Systems**

- **Site Investigations and Detailed Geotechnical Analyses**

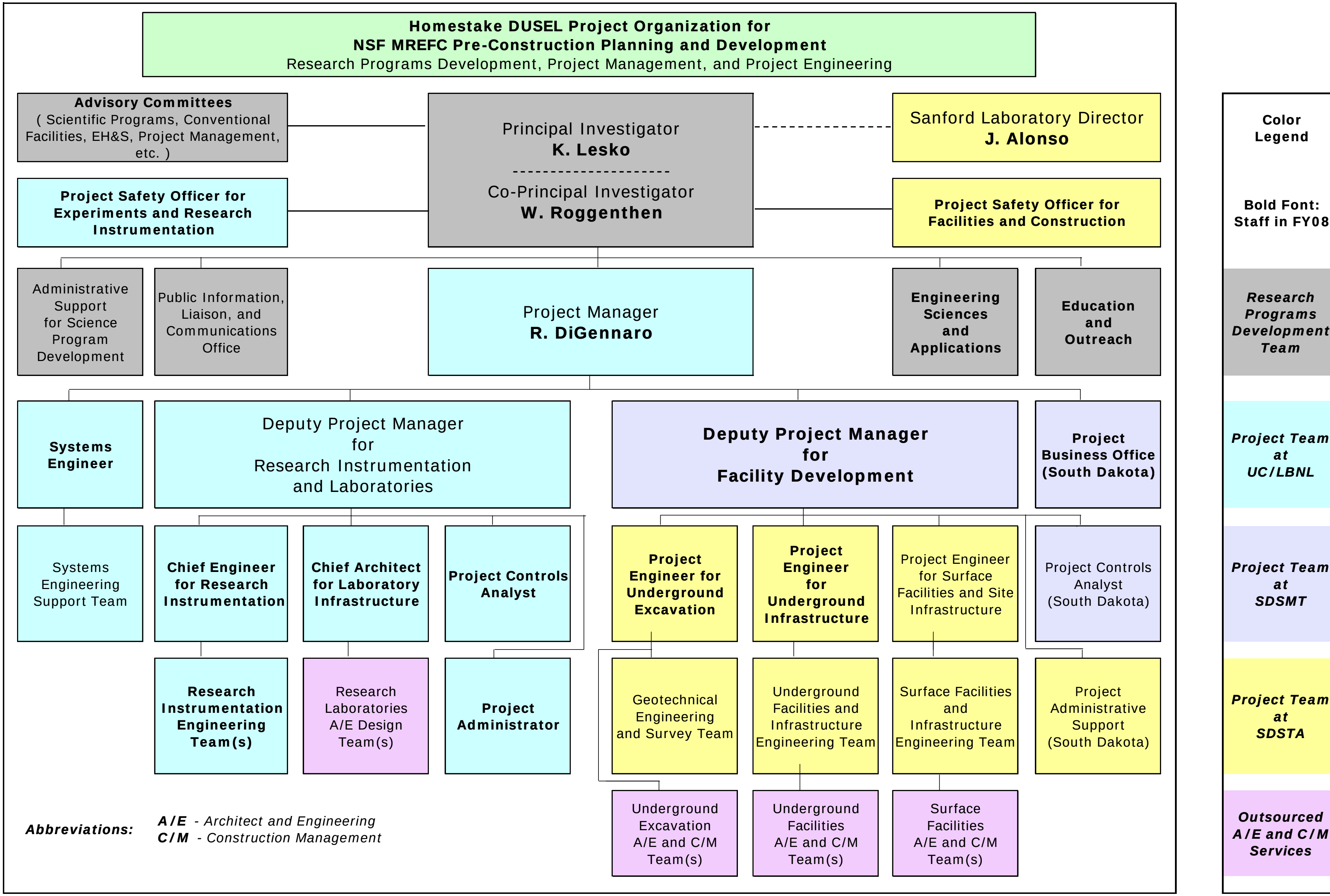
- **U/G Communications, monitoring, IT, cyberinfrastructure**

Proposed Timeline for Sanford Laboratory and DUSEL	Start	Finish
Sanford Laboratory at Homestake		
Ross Shaft Rehab and Pumping Column Commissioning	Jan-07	Feb-08
Yates Shaft Rehab.	Sep-07	Aug-08
Gain safe access to 4850L for EIP construction start, and hold water level at 5000L		Feb-08
Install facility infrastructure for Davis Lab early experiments	Feb-08	Sep-08
Install and commission research instrumentation in Davis Lab	Jul-08	Feb-09
Early experiments in Davis Lab ready for operation		Feb-09
Continued rehabilitation and infrastructure upgrades for Sanford Lab		Dec-10
Transition from Sanford Lab to DUSEL Operations		Jan-11
NSF Deep Underground Science and Engineering Laboratory at Homestake		
Homestake site selection announcement		Jul-07
DUSEL Preconstruction Planning and Development (R&RA)	**Oct-07**	**Sep-12**
Preliminary Design Phase to develop Baseline Cost and Schedule	Oct-07	Dec-08
Preliminary Design Review and National Science Board Recommendation		Mar-09
Final Design Phase	Mar-09	Dec-10
Final Design Review and Authorization for Construction Start		Dec-10
DUSEL Facility - Proposed Construction and Commissioning (MREFC)	**Jan-11**	**Dec-16**
Proposed Construction Start		Jan-11
Near-Surface Campus Construction at 300L		
300L Labs and Education and Outreach Facilities	Jan-11	Jun-12
Mid-Level Campus Construction at 4850 Level		
4850L Common Facilities and Lab Module #1 (Excavation & Lab Build-out)	Jan-11	Oct-12
4850L Lab Modules #2, #3 and #4	Jul-11	Jul-15
Deep-Level Campus Construction at 7400 Level		
7400L Common Facilities and Lab Module #1 (Excavation & Lab Build-out)	Jan-13	Dec-14
7400L Lab Modules #2 and #3	Jan-14	Dec-15
Surface Campus Construction		
Phase 1 Offices and Laboratories	Jul-11	Jul-12
Phase 2 Offices and Laboratories	Jul-13	Jul-14



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 Scientific 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 Project Organization for
NSF MREFC Pre-Construction Planning and Development
Research Programs Development, Project Management, and Project Engineering
Advisory Committees
(Scientific Programs, Conventional Facilities, EH&S, Project Management, etc.)
Principal Investigator
K. Lesko
Co-Principal Investigator
W. Roggenthen
Sanford Laboratory Director
J. Alonso
Project Safety Officer for Experiments and Research Instrumentation
Project Safety Officer for Facilities and Construction
Administrative Support for Science Program Development
Public Information, Liaison, and Communications Office
Project Manager
R. DiGennaro
Engineering Sciences and Applications
Education and Outreach
Systems Engineer
Deputy Project Manager for Research Instrumentation and Laboratories
Deputy Project Manager for Facility Development
Project Business Office (South Dakota)
Systems Engineering Support Team
Chief Engineer for Research Instrumentation
Chief Architect for Laboratory Infrastructure
Project Controls Analyst
Project Engineer for Underground Excavation
Project Engineer for Underground Infrastructure
Project Engineer for Surface Facilities and Site Infrastructure
Project Controls Analyst (South Dakota)
Research Instrumentation Engineering Team(s)
Research Laboratories A/E Design Team(s)
Project Administrator
Geotechnical Engineering and Survey Team
Underground Facilities and Infrastructure Engineering Team
Surface Facilities and Infrastructure Engineering Team
Project Administrative Support (South Dakota)
Underground Excavation A/E and C/M Team(s)
Underground Facilities A/E and C/M Team(s)
Surface Facilities A/E and C/M Team(s)
Abbreviations:
A/E - Architect and Engineering
C/M - Construction Management
Color Legend
Bold Font: Staff in FY08
Research Programs Development Team
Project Team at UC/LBNL
Project Team at SDSMT
Project Team at SDSTA
Outsourced A/E and C/M Services

UNDERGROUND LABS and SPACE

Experiment or Program Name: ____
Principal Investigator or Contact Person: ____
Brief Summary:____

Note: General requirements and lab module infrastructure for physics and earth sciences experiments have been compiled for DUSEL planning (ref. http://www.dusel.org/InfrastrMatrices_rev.xls). As-needed, use this checklist to add, update, or modify information for the proposed experiment.

1. Modules or Functional Uses:

____
____
____
____

2. General Information:

Probable Start (year) _________
Duration __________________
Space (Volume) L x W x H (m^3)
____
Depth/Shielding (mwe) _______
Occupancy (Peak/Avg) _______

3. Mechanical

Temperature
__ Uncontrolled
__ 20 +/- 5 deg. C (Air Cond.)
other:

__ Compressed Air

Cylinder Gases:
__ Inert
__ Flammable
__ Toxic
__ Carbon Dioxide
__ Nitrogen Gas
__ Liquid Nitrogen
__ other: _______________

4. Electrical

Approx. total power (kW)
(Peak/Avg.) _____________
Other electrical needs (describe):
____

5. Chemicals:

Bases

Clean Room_______________
Storage___________________

7. Special Facilities:

Material Access ______________
Access Schedule _____________
Cleanliness _________________
Security ____________________
Data Communication: ________
____

8. Laboratory, Machine Tools, and Other Equipment:

____
____
____
____
____
____

SURFACE LABS and SPACE

Experiment or Program Name: ____
Principal Investigator or Contact Person: ______________________________________
Brief Summary:____

1. Rooms or Functional Uses:

____
____
____

2. General Information:

Probable Start (year) _________
Duration _______________
Space (Approx. Floor Area or Volume)

____

Occupancy (Peak/Avg) _______

3. Mechanical

Temperature
__ Uncontrolled
__ 20 +/- 5 deg. C (Air Cond.)
__ other: _______________
Humidity
__ 50% +/- 20%
__ Uncontrolled
__ other: _______________
Air Filtration/Recirculation (describe):______________

Cylinder Gases:

____
____
____

4. Electrical

Approx. total power (kW) (Peak/Avg.) _____________
Other electrical needs (describe):

____
____

5. Chemicals:

__ Bases
__ Acids
__ Solvents
__ Radioisotopes
__ Chemical inventory storage
__ Chemical waste storage
__ Biological storage
__ Radioisotope storage
__ Cryogenics
__ Hazardous/Special Handling:
____

7. Special Facilities:

Material Access ______________
Access Schedule _____________
Cleanliness _________________
Security ____________________
Crane Access:_______________
Data Communication: ________
____

8. Laboratory, Machine Tools, and Other Equipment:

____
____
____
____
____
____
____
____
____
____

9. Other Needs or Requests:

Systems Engineering - Requirements Management Database

Requirement Number ID: A unique serial number identifier for each record.

***Work Breakdown Structure**:* WBS # reference for project controls and review.

***Organization**:* Institution, user group, or experiment representing the origin for the defined need or constraint.

***Owner**:* Named individual who is responsible throughout the project design and execution process to verify that the requirement is achieved or to identify and report deviations.

***System**:* Top-level grouping for an experiment, common facility, institutional program, or regulatory agency.

***Sub-system**:* Mid-level grouping by elements within each system.

***Topic**:* Lowest-level grouping by engineering discipline or project management categories.

***Requirement Statement**:* Concise, summary definition of functional objectives (what the system must do) or performance objectives (how well it must be done).

***Rationale**:* Optional supplementary information to further explain the requirement statement.

***Type**:* Basis for the requirement, such as functional, performance, budgetary, regulatory, interface, etc.

Source(s): Examples: Funding or regulatory agencies (e.g., NSF, DOE, MSHA, OSHA, DENR, laws & statutes), Institutional (SDSTA, Homestake Lab, LBNL, Site-specific design criteria), Programmatic (Education & To-be-determined (TBD), Draft, Defined, Approved, Verified, Deleted, or Obsolete Outreach, Maintenance & Operations, Environment, Health, Safety & Security, Policies and Procedures), Users Experimental and Research (Functional, Performance, Analysis, Existing Conditions), Subcontracts and Industry Standards, Lessons Learned.

URL Link(s): Optional, additional reference information or detailed requirements documentation.

***Comments & Revision Note**:* Optional descriptive narrative.

Supplementary Slides

Systems Engineering Toolkit

Objective: 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

Environment, Health & Safety and Project Execution Plan

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)

Environment, Health & Safety and Project Execution Plan

1. Environment, Health and Safety and Integrated Safety Management (cont.)

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

2. Project Execution Plan (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

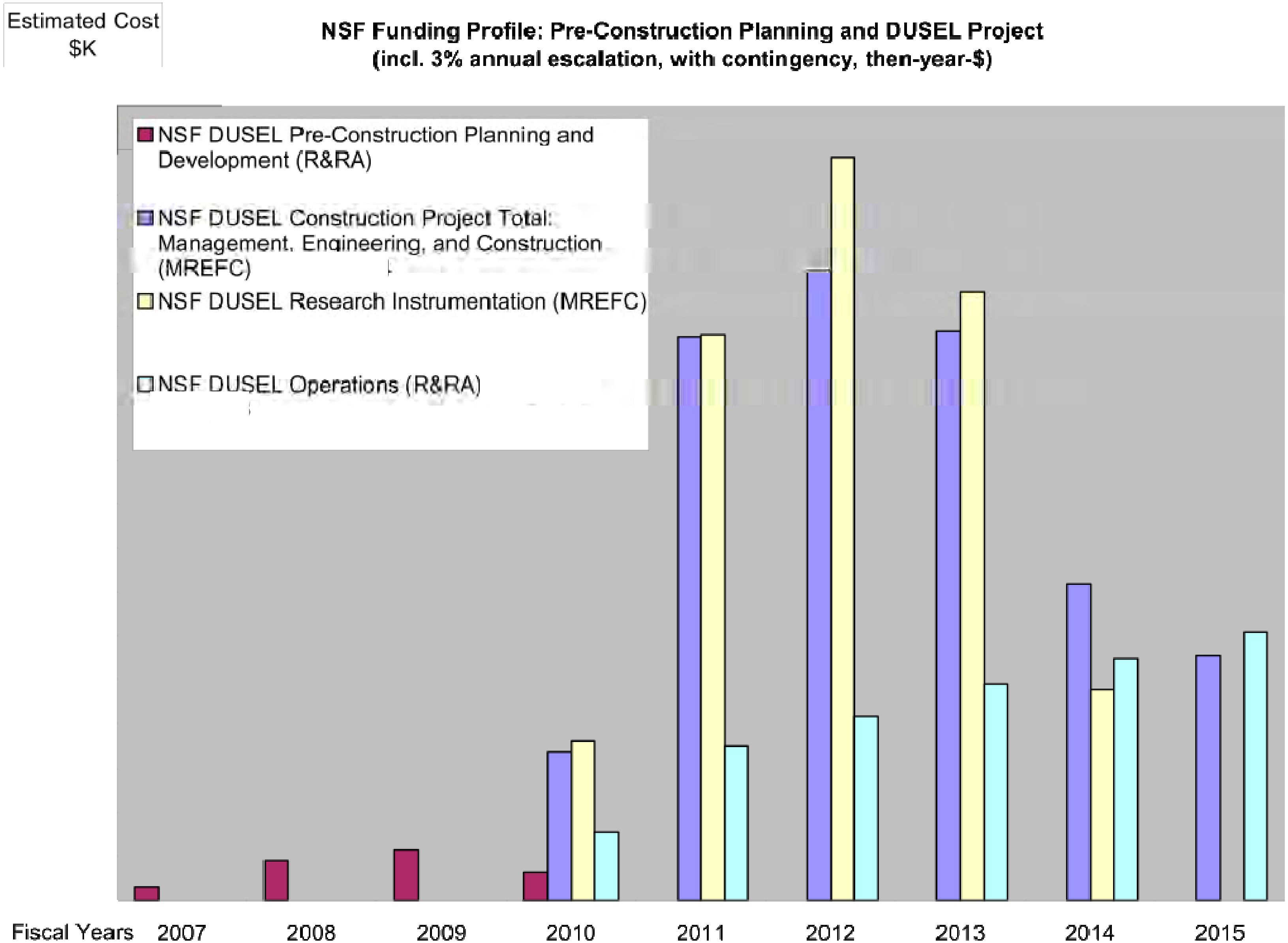
2.10 Project Management Control System
- 2.10.1 Baseline Cost and Schedule Performance Parameters
- 2.10.2 Resource-loaded Project Schedule
- 2.10.3 Preliminary Risk Analysis and Risk Mitigation
- 2.10.4 Preliminary Cost Estimate and Contingency Analysis
- 2.10.5 Partnerships and Partnership Funding
- 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

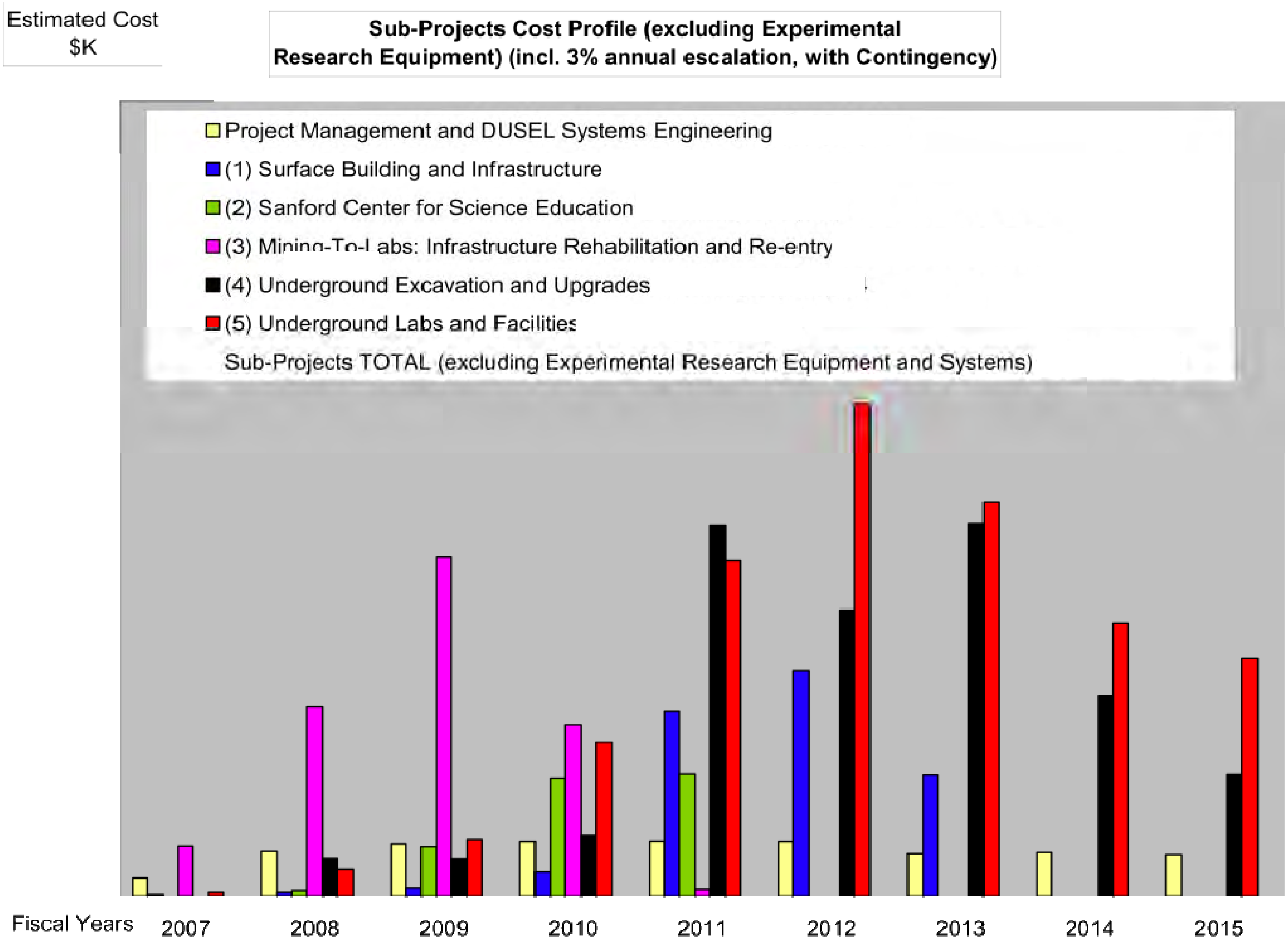
3. Summary: Technical Feasibility and Constructability

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

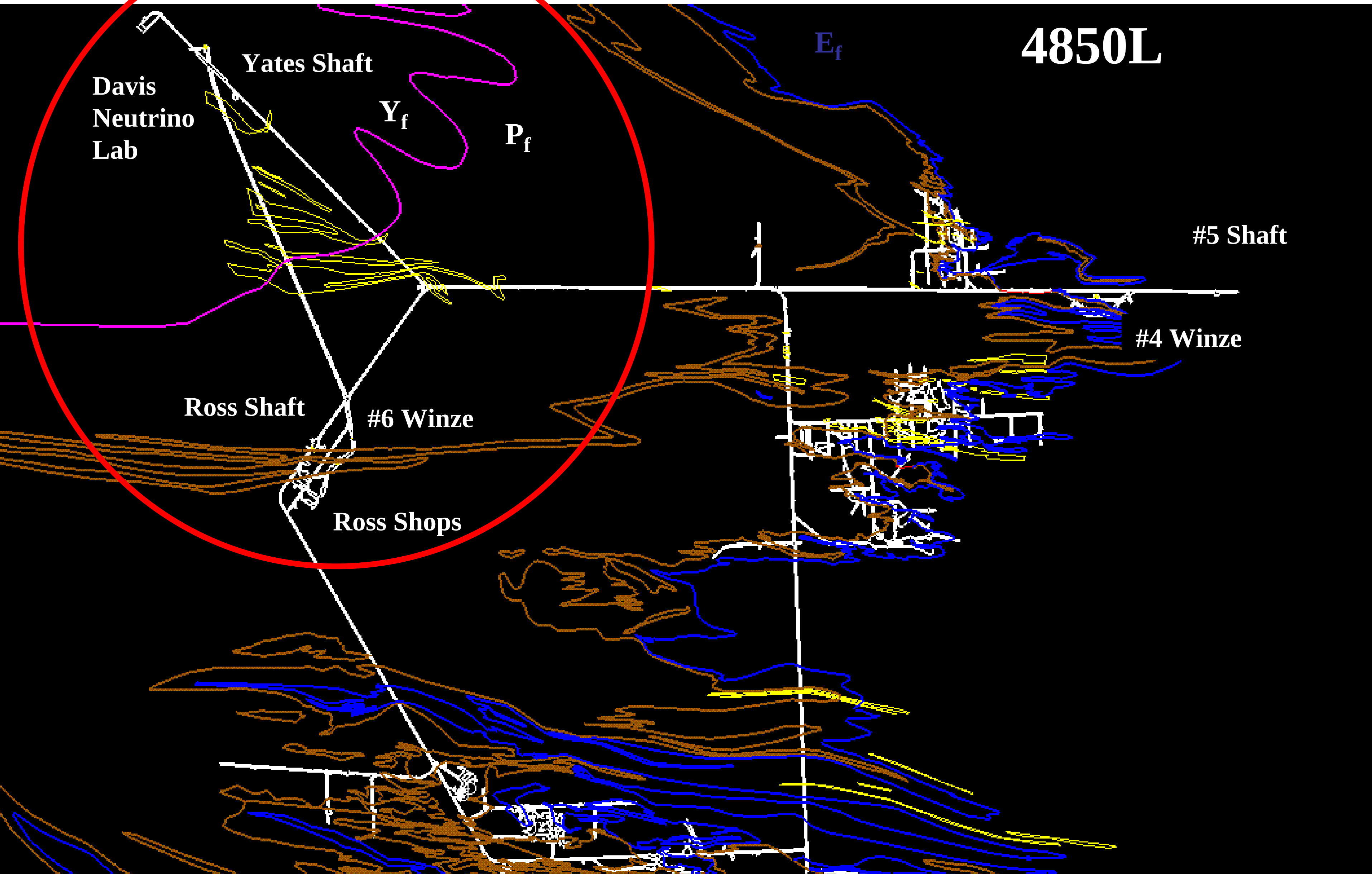


Estimated Cost $K
NSF Funding Profile: Pre-Construction Planning and DUSEL Project
(incl. 3% annual escalation, with contingency, then-year-$)
NSF DUSEL Pre-Construction Planning and Development (R&RA)
NSF DUSEL Construction Project Total: Management, Engineering, and Construction (MREFC)
NSF DUSEL Research Instrumentation (MREFC)
NSF DUSEL Operations (R&RA)
Fiscal Years
2007
2008
2009
2010
2011
2012
2013
2014
2015



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

Existing Drifts and Access for Campus Development at 4850 Level



Existing Drifts and Access for Campus Development at 7400 Level