NUSEL and the Underground Accelerator

- Concept of a deep US underground lab came to the fore in September 2000, with NSAC Long Range Plan Process
- Endorsed by NSAC, supported by HEPAC, and recommended by two National Research Council studies
- NSF NUSEL-Homestake proposal submitted in June 2001
  - Reference Design Project Book submitted July 2003
  - proposed development of a room at 4850-ft level to house an underground accelerator
  - Homestake difficulties since that time
- Has prompted discussion of alternate sites: deep Soudan, ...
- motivated a broad search for horizontal-access alternatives

Reference Design Project Book Process

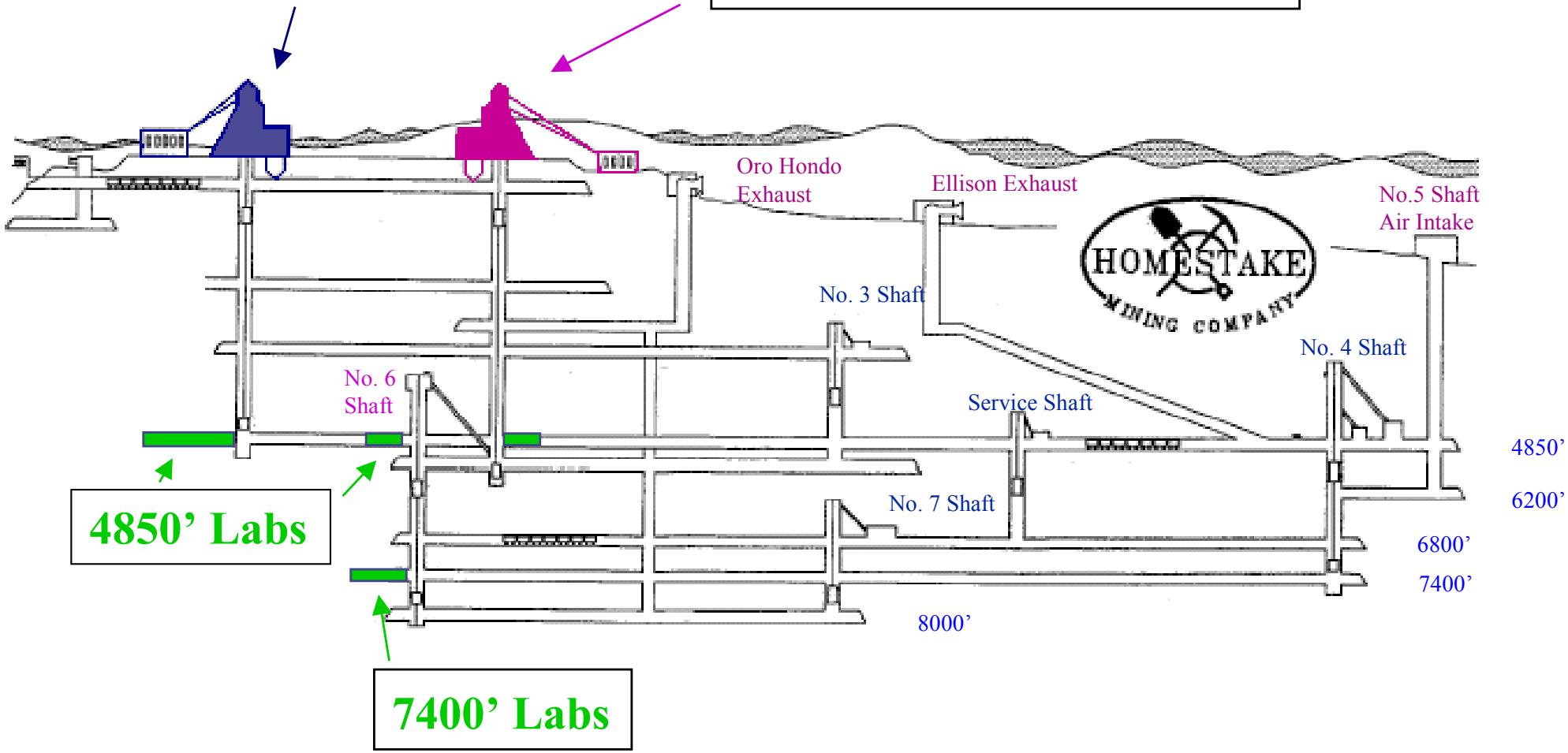
- Decided in fall, 2002, that we could not wait for progress on site issue: conceptual proposal was not adequate for serious NSF consideration of Homestake
- Major cost items of original proposal (Yates extension, major drift extension) had been poorly engineered, and were not costed realistically
- Proposed a conceptual design to our engineers (Aberle, Marks, Skyline Engineering)
- They endorsed the concepts; reported back to the Executive Committee, in our January meeting, on cage sizes that could be produced, ventilation schemes, etc
- Murdock Trust, Vancouver WA, provided grant to support South Dakota engineering; UW, LANL, etc provided additional support

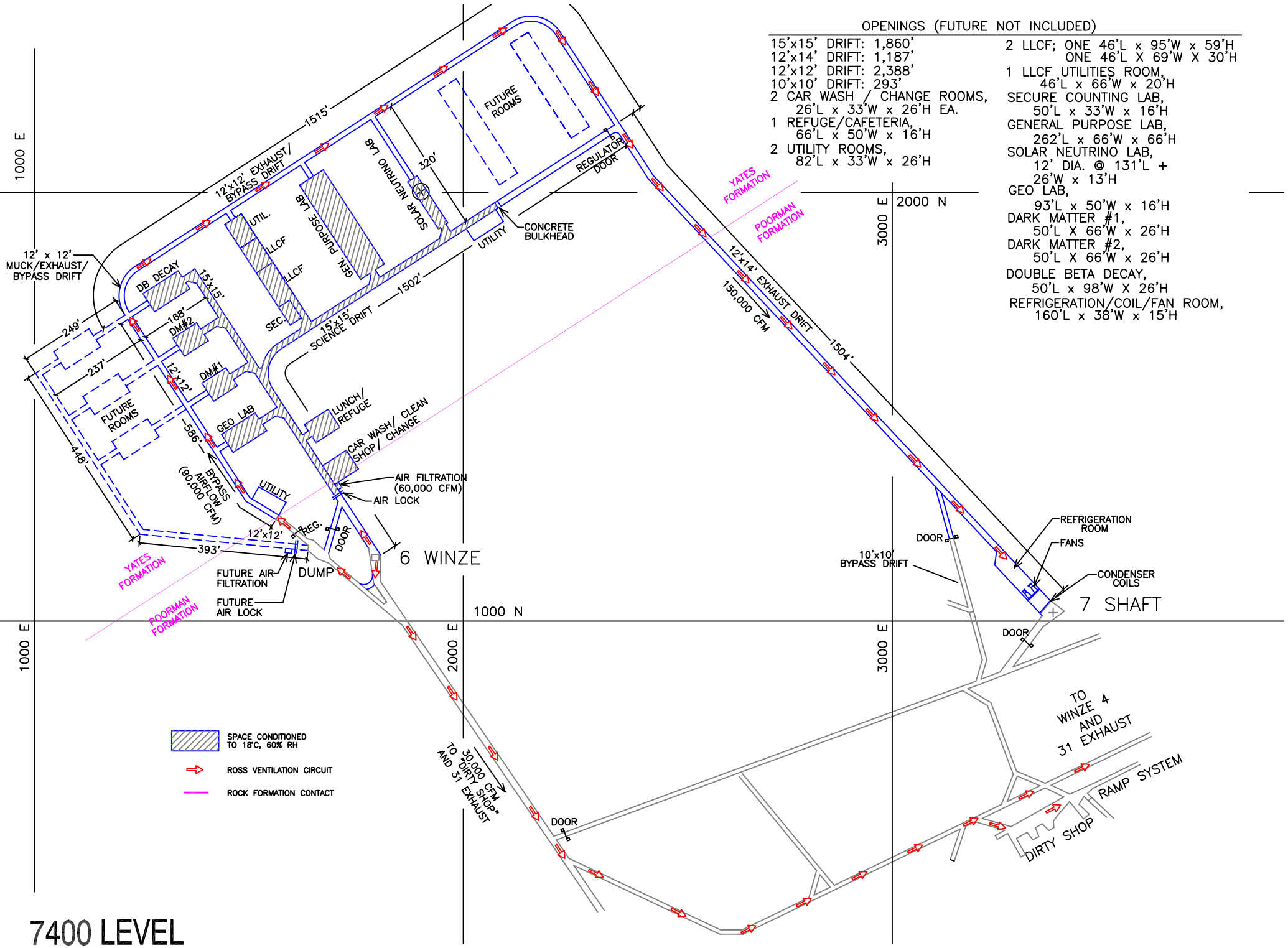
- RDPB contained our Science Book: science/lab requirements document that included input from Lead/Aspen/NESS02 meetings
- Resulting split-level design
- Hard copies sent to NSF, NSAC, HEPAP, etc in July 2003
- Submit revised Homestake plan: NSF receives a shorten version as a formal second-stage proposal
- Posted on archive

NUSL Overview (cross-section)

Yates Shaft and Complex Mining and Operations

Ross Shaft and Complex Science Operations

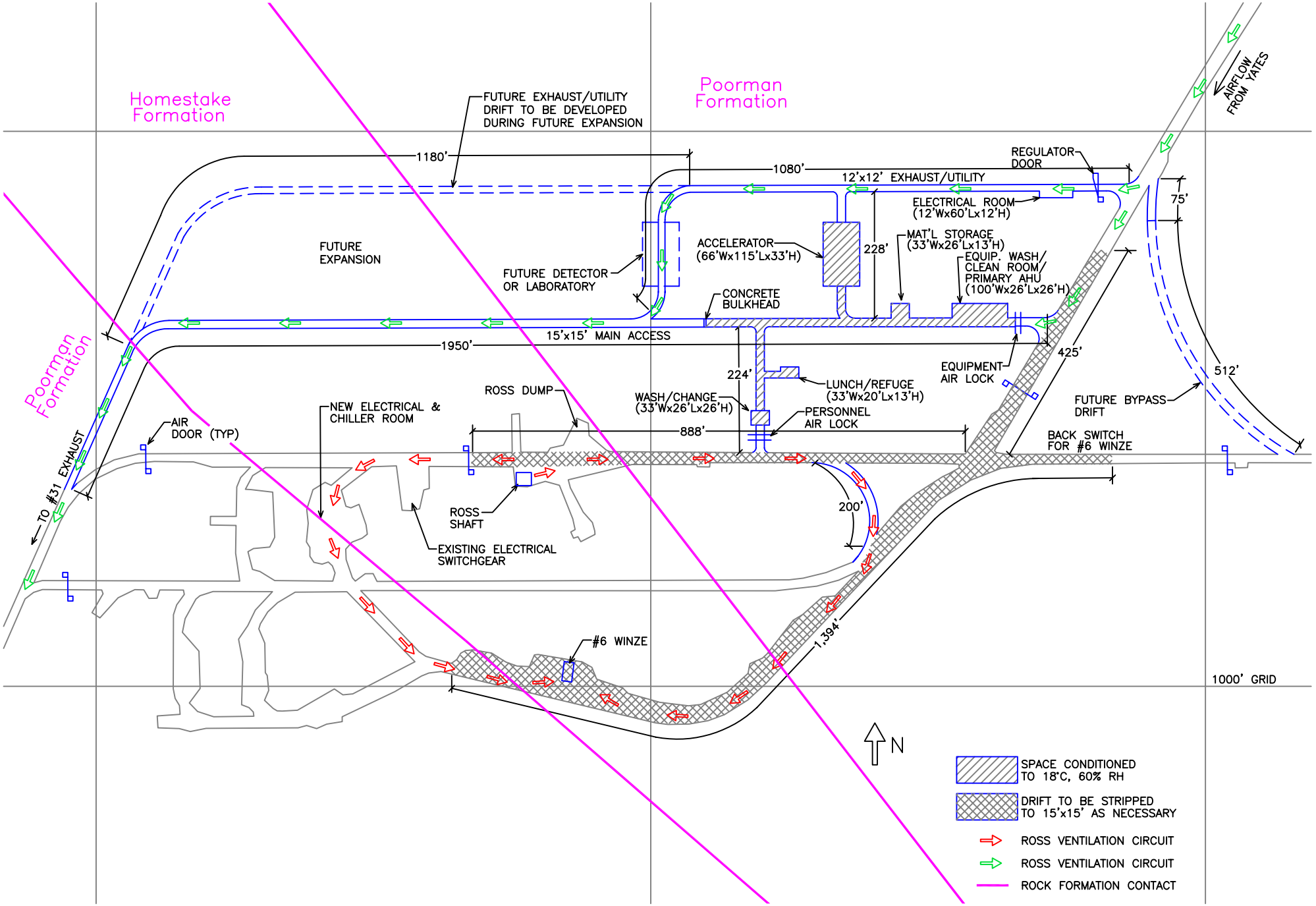




7400 LEVEL

06-03-03

NO SCALE



4850 LEVEL

05-29-03

NO SCALE

Accelerator Hall Layout, Uncertainties

- Dimensions taken from Lead and NESS02 discussions: W $\times$ L $\times$ H = 20 $\times$ 35 $\times$ 10 + 5 $\times$ 10 $\times$ 4 (m)
- Yields 8000 m^3 and a floorspace of 750 m^3
- Homestake RDPB placed this on different level because great depth not necessary, some radiation concerns arose, and it was attractive to have a lead facility for this level
- Treated as a cleanroom with an equipment wash: is this necessary?

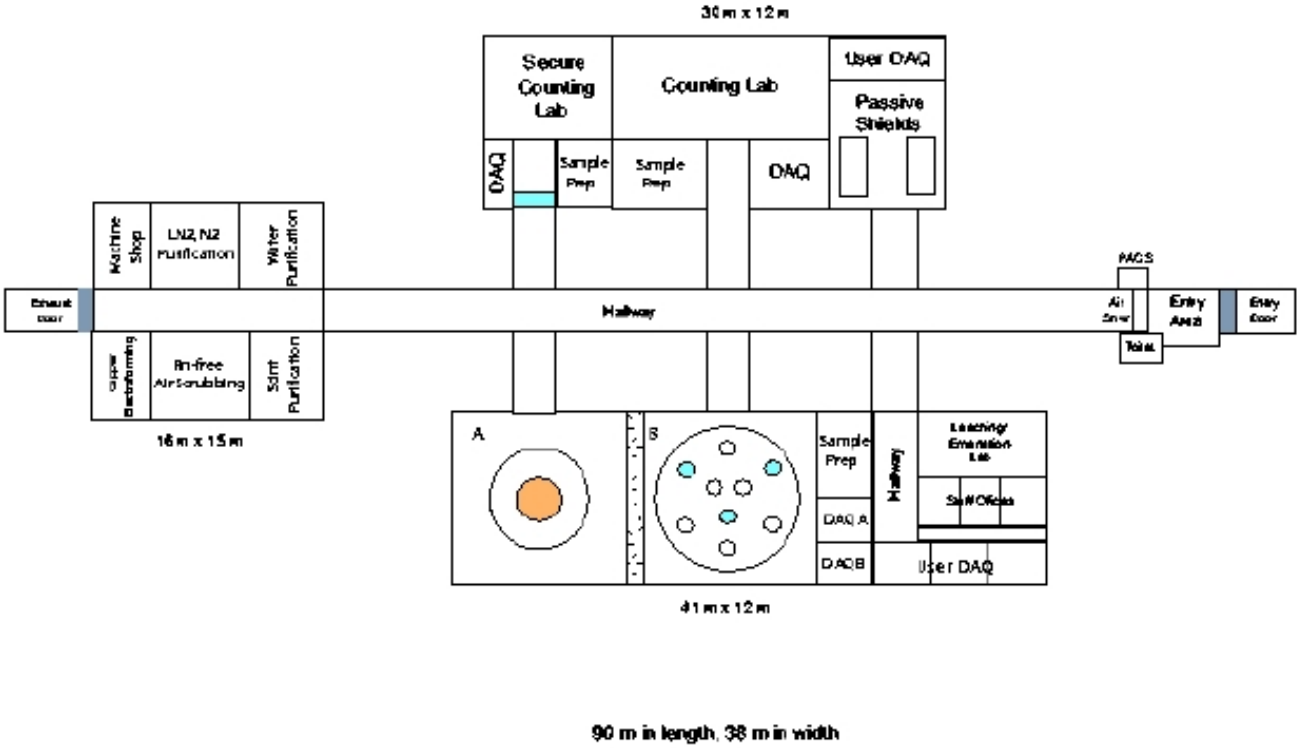


Figure E.16: One of two configurations now under consideration for the low-level counting facility.

NSF Panel Site Selection

- NSF site panel convened in May 2003
- Reviewed Homestake, San Jacinto, new Soudan proposals
- Charged with evaluating 1) geotechnical suitability and 2) cost effectiveness
- Panel was described as an engineering panel: not aware of any physics representation
- Based on original conceptual proposal

- Report generated some unhappiness
  - Cost effectiveness defined only in terms of construction costs: ignored operations costs, which favor San Jacinto
  - Unanimously endorsed Homestake, and unanimously called for continued maintenance of mine

- Considered deep Soudan acceptable
- Considered San Jacinto unacceptable for a variety of reasons, including the inability to perform direct geotechnical explorations of most of the tunnel path

- UC Irvine disputed results in a letter to the NSF

Setbacks of the Summer

- Barrick began flooding the mine 10 days after the Panel Report was issued
  - Public arguments that it was cost effective to do so are not consistent with the views of our engineers
  - Apparently was done to establish Homestake as abandoned, removing Barrick further from liability associated with our future use
- Consequences of the flooding
  - Estimates of flooding rate 350-500 gpm: likely to reach 7400 ft level in 18-24 months (vs. FY06 earliest funding date)
  - Ventilation lost to lower half of the mine: will be exposed to high heat, humidity for 4-5 years, with consequences for all infrastructure, ground support

- dewatering a major engineering challenge: one must lower portable pumps down the No 6 shaft, after regaining access through the ramp system; use the ramps for the pump column path
- with 6 months for engineering and contracting, and assuming 1500 gpm for pumping capacity, the dewatering will require 2.1y, assuming an FY06 funding start
- must install permanent pumps, repair all infrastructure, inspect and repair ground support, recertify for operations
- water temperature, quality?
- severe problems for the geomicrobiology and hydrology programs; 3D access to 9 km^3 unlikely

- Cost estimates have ranged up to $70M

- Barrick has followed its usual mine closure plan
- Most of the underground infrastructure we had planned to inherit has been lost
  - Barrick and the state have agreed that NUSEL must replace both the pumping and electrical systems
  - much of the electrical system is less than 5 years old
  - issue appears to be company and state liability
  - replacement cost likely in excess of $50M
- State legislative special session to consider site transfer legislation, planned for August, postponed
  - we are concerned the the site transfer is a complicated and lengthy legal process requiring a great deal of technical input
  - ”NUSEL Authority” created by state is a positive step: our group has agreed to assist

- Our analysis is that the unresolved site issues are now compounded by three additional problems:
  - escalation of reconstruction costs
  - loss of Homestake's time-to-first-physics advantage
  - introduction of additional risk
  - Bahcall Report anticipated this: pointed out Homestake's advantages would disappear if we were unable to move ahead quickly
- cost analysis
  - baseline RDPB cost $321M
  - dewatering: $\sim$ $40M + contingency
  - repairing ground support: ??
  - pumping and electrical system replacements; additional hoist repairs $\sim$ $50M + contingency

- liability insurance for Barrick/State: rule-of-thumb $\sim$ \$2-4M/y
- total construction costs likely in excess of \$450M
- nonscientific operations costs \$9.6M + \$2-4M vs $\sim$ \$2M for one horizontal-access site

- time delay due to flooding, reconstruction $\sim$ 3 y
- risks?
  - very large investments required to reclaim, recertify mine; required before we core the 7400-ft level Yates formation rock; (still have confidence in that rock)
  - geomicrobiology problem likely lost; hydrology program hurt; desired EarthLab broad access likely lost

- Bahcall report has proven very insightful
- Supported San Jacinto ”greenfield” horizontal-access proposal
  - cheaper to operate
  - more convenient access, construction of experiments
  - advantages of engineering from scratch to optimize science
- Favored Homestake: pluses overcame drawbacks of more expensive operations, less convenient access
  - faster time to first physics
  - existing infrastructure
  - skilled workforce in place
- Quick transfer essential to preserving Homestake advantages
  - now complicated by unforeseen liability costs, mining legacy issues

- New deep-Soudan proposal provides one option: vertical access
- Also have SNOLab – analogous to old Homestake, parasitic shared use of an active mine
- Bahcall Report also pointed out that no one had done a careful search to identify horizontal-access sites
  - after Homestake flooding, a few Homestake proponents did such a study
  - looked in California, Nevada, New Mexico, Colorado, Arizona, Washington
  - most reasonable sites similar to San Jacinto: granite batholiths
  - one site stood out

- Local search initial criteria
  - a minimum – not peak – overburden of at least 5000 ft
  - a site that can be clearly developed and physically explored: private, National Forest, or possibly Federal Recreational Area lands
- Secondary considerations
  - political use issues: e.g., areas under consideration as wilderness areas, or where environmental controversies exist
  - accessibility: roads, utilities, climate/altitude
  - cost issues: tunnel lengths, other factors
  - permitting issues
- examples of interesting but problematic sites
  - Colorado: Pikes peak
    - long tunnel required (8-9 km)

- very high altitude portal
- Pikes Peak granite's relatively poor reputation

- Colorado: West Spanish Mountain
  - local effort to classify as Wilderness
  - longer tunnel, modest overburden
- Arizona: Mt. Graham
  - squirrels
  - long tunnel required

- left a list of about 12 interesting sites
  - state geologist cut: permitting, environmental opposition, rock quality, hydrology
  - Shannon & Wilson

- examples of some contenders
  - Cashmere Mt: peak cover $\sim$ 6421 ft, min. cover $\sim$ 5478
  - Montgomery Pk: peak cover $\sim$ 6516, min. cover $\sim$ 6407
  - Pyramid Pk: peak cover $\sim$ 7340, min. cover $\sim$ 6324
- choice: Cashmere Mt/Icicle Creek
- rated first in most of the criteria we felt were important
  - rock: high-quality granite of the Mt. Stuart batholith, eastern Cascades (largest in US)
    - all but 400 yards of the tunnel path on matrix National Forest land: can be cored
    - well away from only major fault; no quake above 4.1 in eastern Washington in 40 years
    - same rock formation in which the old and new Burlington-Northern Cascades rail tunnels were drilled: record-setting

tunnels, unsupported, stable after 100 years; remarkably dry

- ⋆ can be used to evaluate rock properties
- ⋆ very similar geologically to San Jacinto, but without SJ drawbacks

◇ construction costs: tunnels would be 5 km in length – as short as any found; geologists recommend negative gradient design at 6% – 7210 ft peak cover, 6270 ft minimum cover

◇ access from SeaTac: I5 to Highway 2 to Icicle Creek Road

- ⋆ Interstate $\rightarrow$ major highway $\rightarrow$ secondary highway
- ⋆ 103 miles from SeaTac
- ⋆ kept snowfree
- ⋆ Icicle Creek Road gradient 2%, straight: portals immediately off road

- climate and elevation: 27 in. total precipitation; 300 sunny days; July/August: 87/50; Dec/Jan: 34/19; proposed portal at 2100 ft
- utilities provided by Chelan PUD
  - 80% of SJ nonscientific operations costs due to electricity: $\sim$ \$6M/year
  - comparative rate: \$0.020, \$0.087, and \$0.138 for Chelan, national average, and San Jacinto
  - need to bring a 12 kV line underground about 6 miles to portal
- no mining or other industrial legacy issues: owned by US (National Forest matrix lands)
- excellent potential site for science building 6 miles from portals

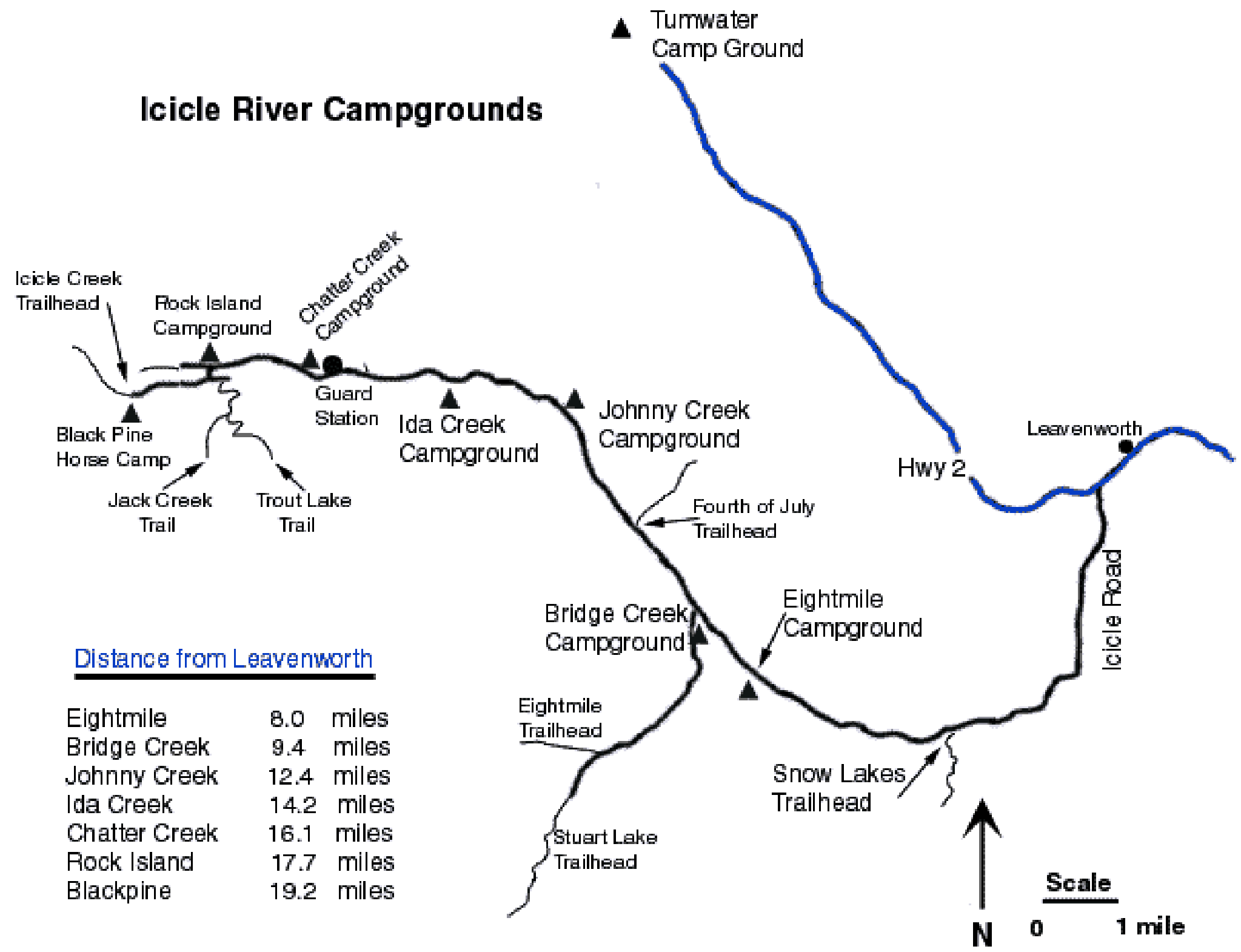
- many visitor accommodations: 50 hotels and B&Bs within 12 miles
- rock disposal: most on proposed science building site (to rehabilitate gravel pit); other disposal sites nearby
- well-defined permitting process
- excellent long-baseline distances from FNAL, reasonable for BNL
- very supportive county, state

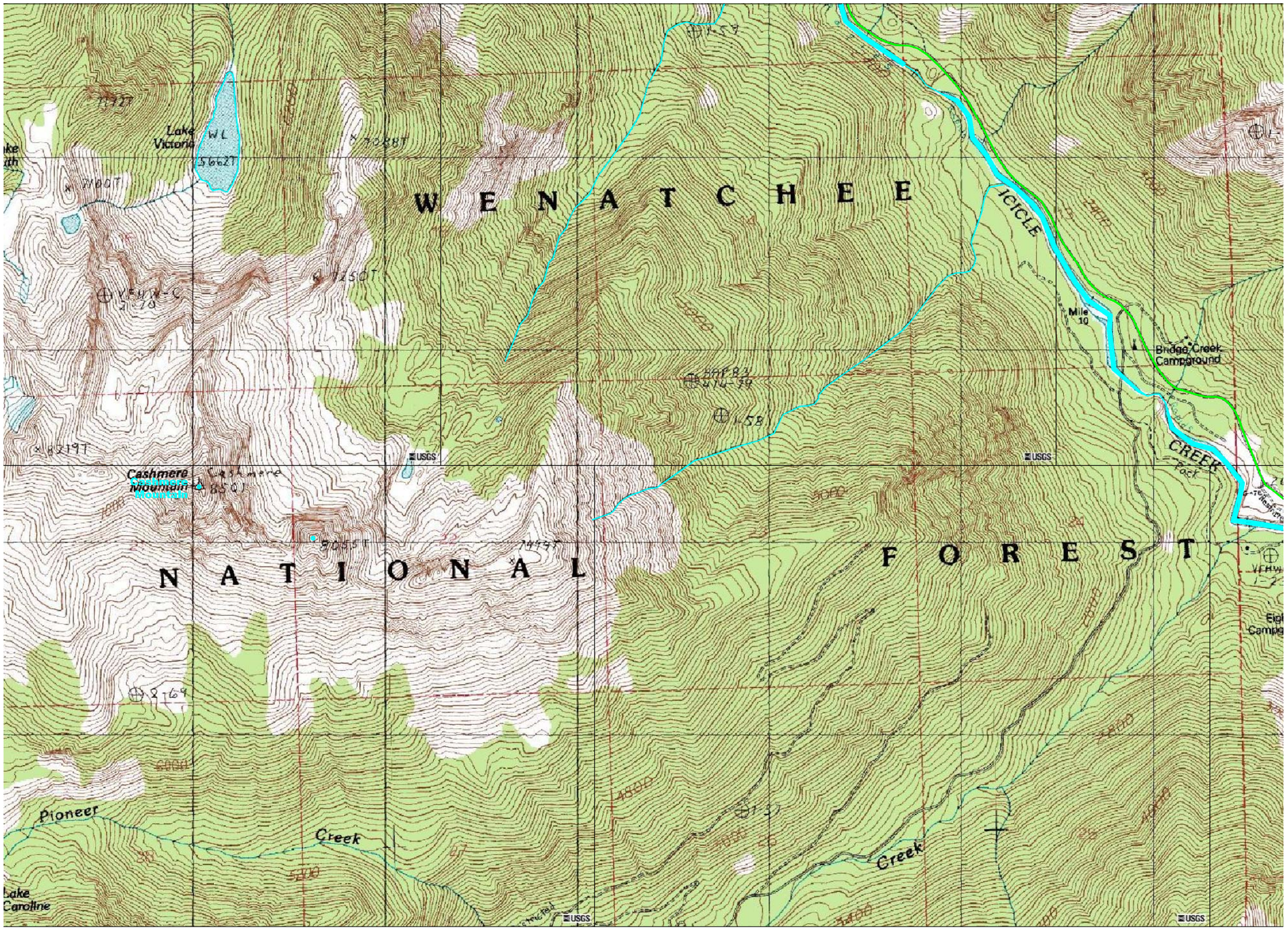
Outstanding Issues

- Waiting for geotechnical report of Shannon and Wilson: will give us quantitative measures of rock hardness, hydrology, etc
- Permitting progress: state, UW have provided excellent lawyers who want to do the full EIS at the outset
  - consistency with Northwest National Forest plan
  - water rights, discharge issues: state Dept of Ecology
  - USFS use permits for coring, well, tunnel drilling, parking, improvement of existing road to portal
  - gravel pit rehabilitation: Dept Natural Resources permit
  - utility easements
  - Chelan Co master use, building permits
- Now meeting with local environment, preservational groups
  - support for science, education, economic revival

- worries about impacts
- open process of examining, mitigating

- But appears to lack a showstopper like Homestake (no site transfer, flooding) or San Jacinto (NSF unwilling to accept geotechnical unknowns)
- Favorable construction costs, extremely favorable operating costs, relative quick construction


Icicle River Campgrounds
Turnwater
Camp Ground
Icicle Creek
Trailhead
Rock Island
Campground
Chatter Creek
Campground
Guard
Station
Ida Creek
Campground
Johnny Creek
Campground
Black Pine
Horse Camp
Jack Creek
Trail
Trout Lake
Trail
Fourth of July
Trailhead
Hwy 2
Leavenworth
Icicle Road
Bridge Creek
Campground
Eightmile
Campground
Eightmile
Trailhead
Snow Lakes
Trailhead
Stuart Lake
Trailhead
Distance from Leavenworth
Eightmile 8.0 miles
Bridge Creek 9.4 miles
Johnny Creek 12.4 miles
Ida Creek 14.2 miles
Chatter Creek 16.1 miles
Rock Island 17.7 miles
Blackpine 19.2 miles
N
Scale
0
1 mile



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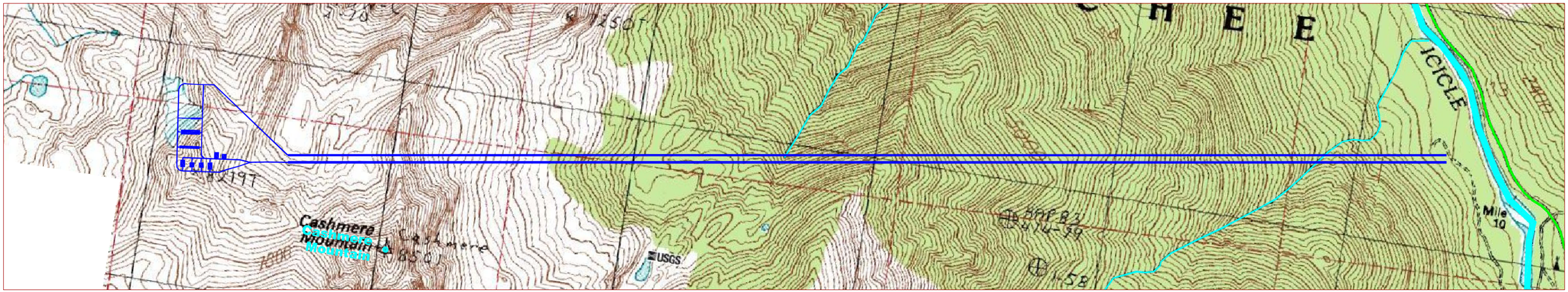
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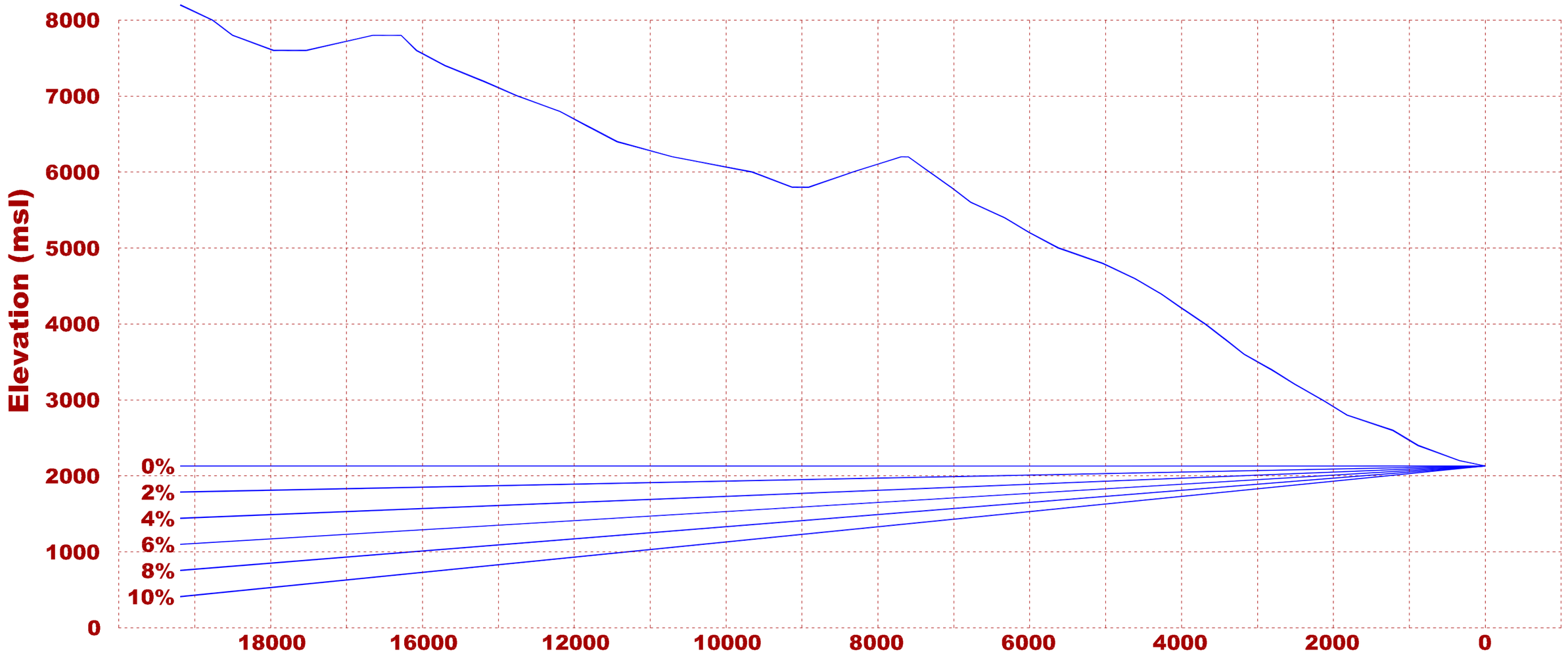
Elevation (msl)
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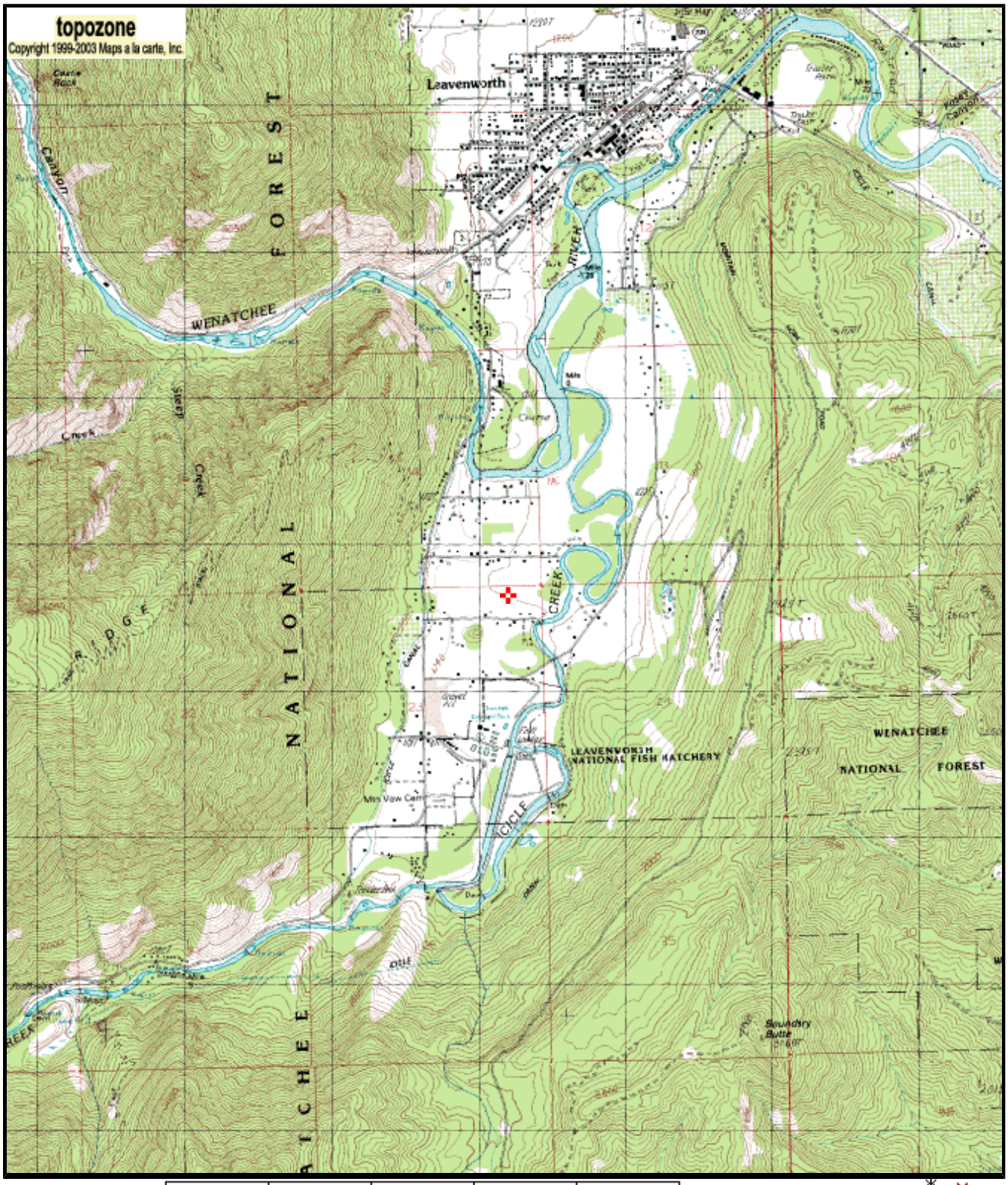

Map center is UTM 10 675098E 5270876N (WGS84/NAD83)
Leavenworth quadrangle - TopoZone Pro elevation display
Projection is UTM Zone 10 NAD83 Datum


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