Elizabeth Mine
Strafford, VT

Phase II Remedial Action

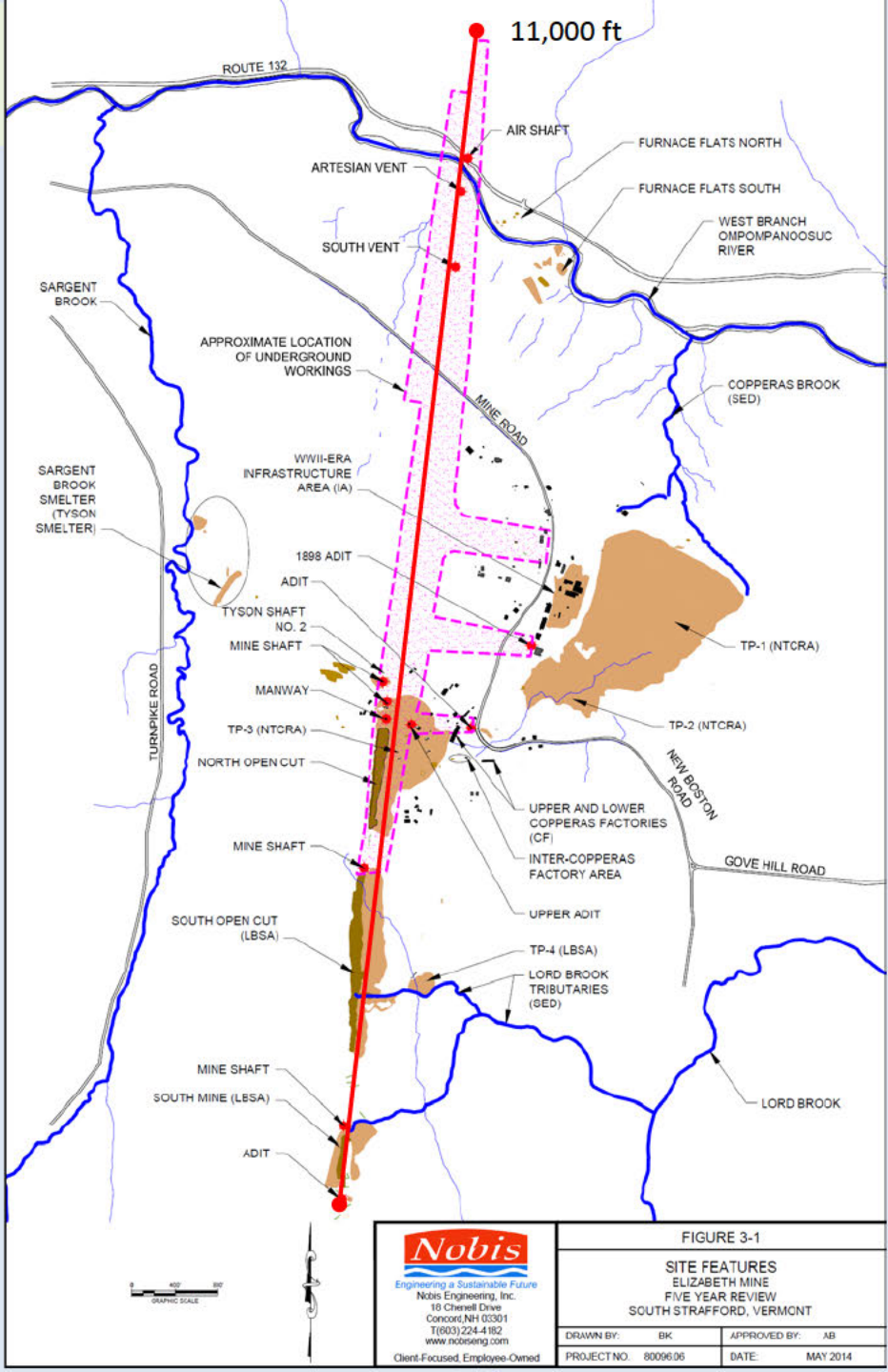
Priority Panel Presentation

November 4, 2014

Elizabeth Mine Phase 2 Remedial Action Background Information

Elizabeth Mine

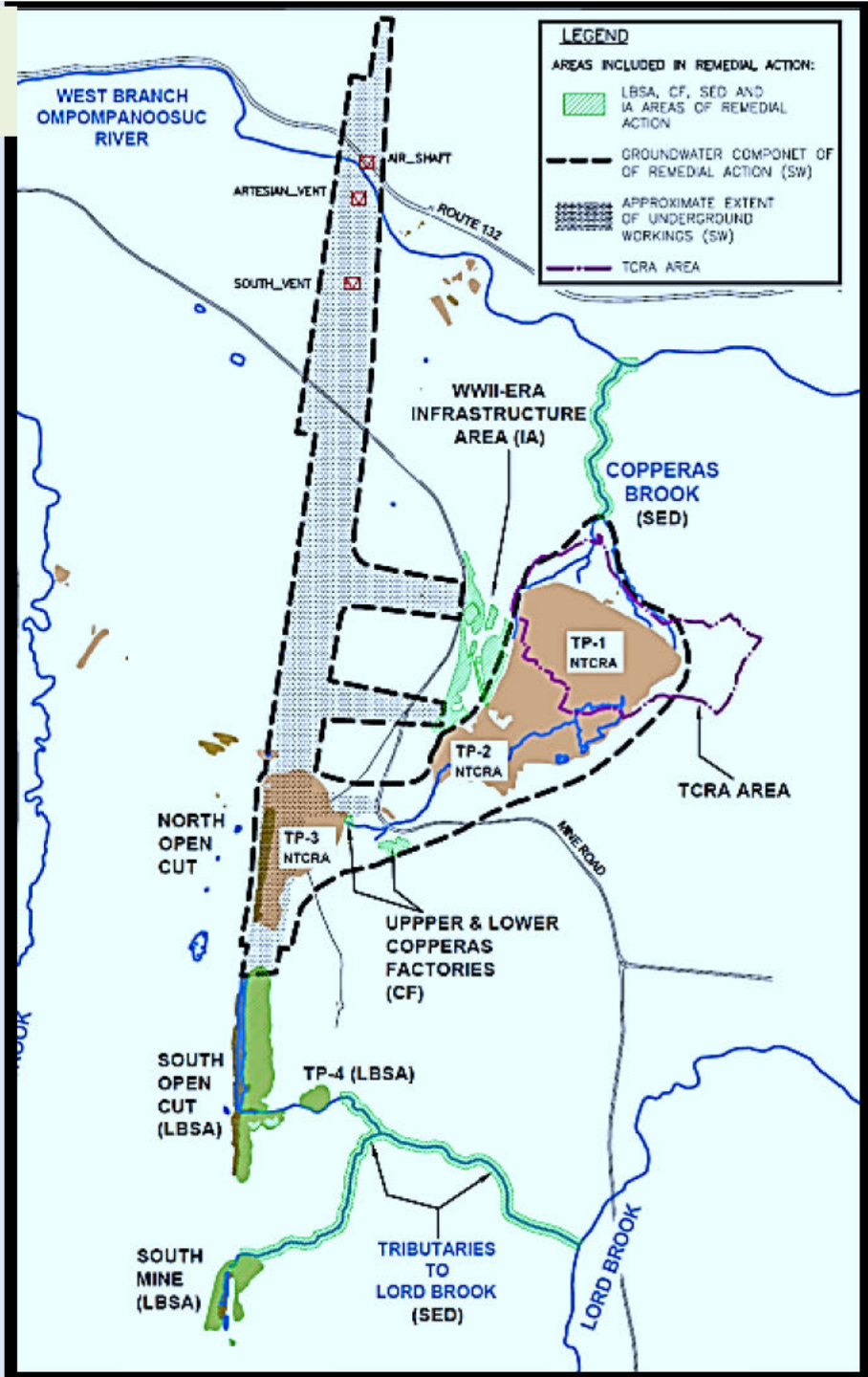
- Operated intermittently from 1809 to 1958.
- Copperas production 1809 – 1880's
  - TP-3 leach piles and waste rock
  - Copperas Factories
- Majority of tailing from 1942-1958 flotation mill operation.
- Remnants from mining activities extend over an area of about 1 square mile and include:
  - Waste rock piles and roast beds (TP-3 and TP-4).
  - Tailing Impoundment and Tailing Dam (TP-1 and TP-2).
  - Former ore crushing and flotation mill facilities.
  - Three open bedrock excavations – two with pit lakes
    - South Open Cut (pit lake)
    - South Mine (pit lake)
    - North Open Cut
  - Underground workings
    - 8,000 linear feet of shafts and adits extending 900 feet below the ground surface.
    - Majority of underground workings are flooded, creating mine pool.
  - Small scale smelting and roast bed areas
    - Sargent Smelter
    - Furnace Flats
  - Open shafts and adits



Elizabeth Mine Phase 2 Remedial Action
Overview of Cleanup Action for Entire Site

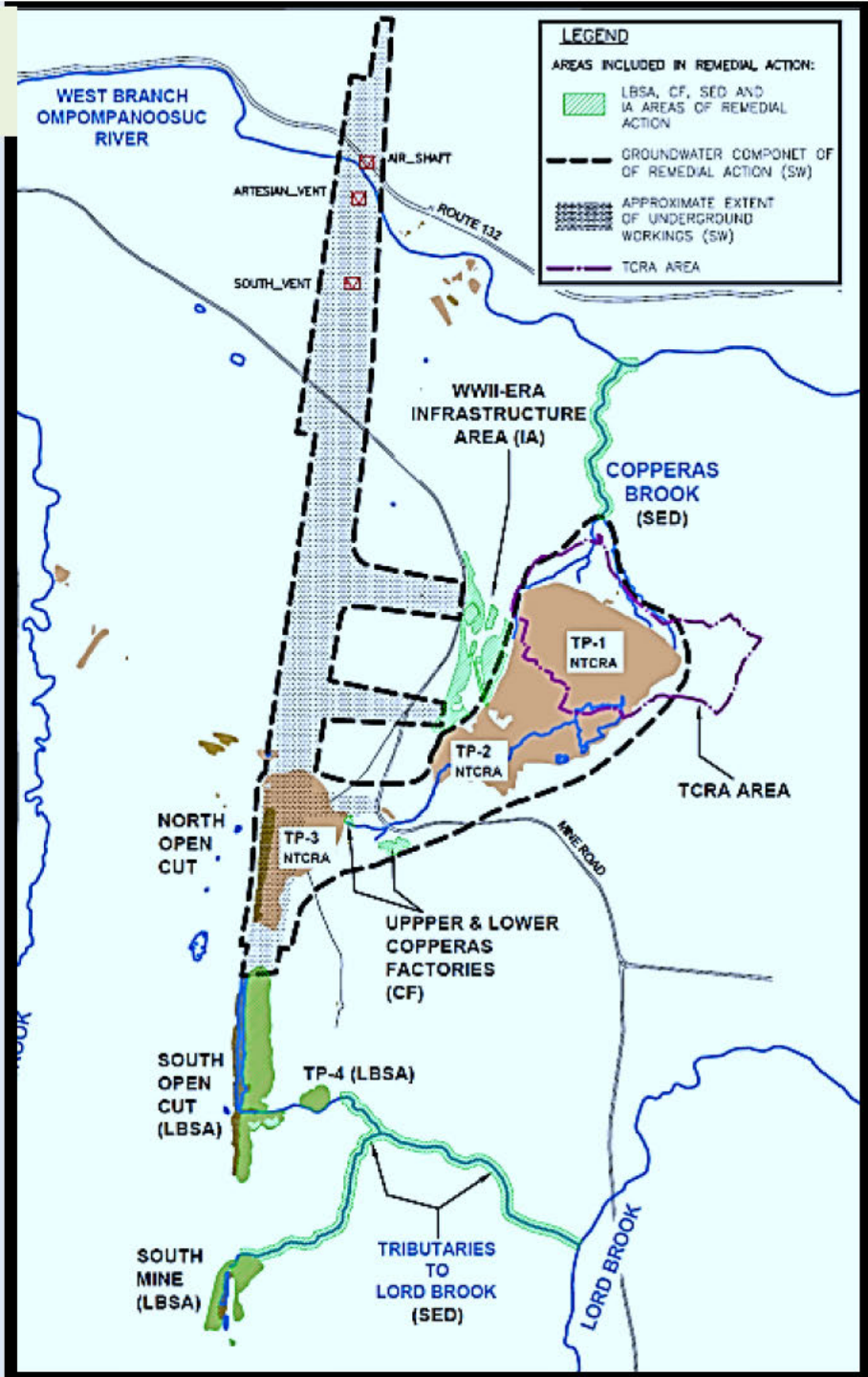
- Time-Critical Removal Action (TCRA)
  - Stabilize TP-1 tailing dam with buttress, toe drain system, and surface water diversion.
  - Completed in 2005

- Non-Time-Critical Removal Action (NTCRA)
  - Mitigate acid mine drainage impacts to Copperas Brook and West Branch of Ompompanoosuc River.
  - Phase 1: Surface water diversion, water treatment system, and groundwater interceptor trench.
    - Completed in 2010.
  - Phase 2: TP-1/TP-2 cover system, waste consolidation, surface water diversion, water treatment system, and site restoration.
    - Most work completed in 2014 with some activities remaining due to be completed in 2015/2016.
  - Phase 3: Passive treatment system for leachate from TP-1.
    - Implementation in 2016.



Elizabeth Mine Phase 2 Remedial Action
Overview of Cleanup Action for Entire Site

- Remedial Action (RA)
  - Phase 1 RA: Copperas Factories.
    - Lead contaminated soil cleanup.
    - Completed in 2010.
  - Phase 2 RA: Lord Brook Source Areas.
    - Mitigate acid mine drainage from South Mine, South Open Cut, and TP-4.
    - Design completed September 2014.
    - Focus of this panel submission.
  - Phase 3 RA: Site-wide Groundwater
    - Groundwater contamination associated with underground workings.
    - Site-wide groundwater use restrictions; long-term monitoring of surface water, sediments, and groundwater; land-use restrictions; and final site restoration.
    - Ongoing design (2016 completion).



TCRA, NTCRA, and Phase 1 RA Work Completed to Date

TCRA, NTCRA, and Phase 1 RA Work Completed to Date

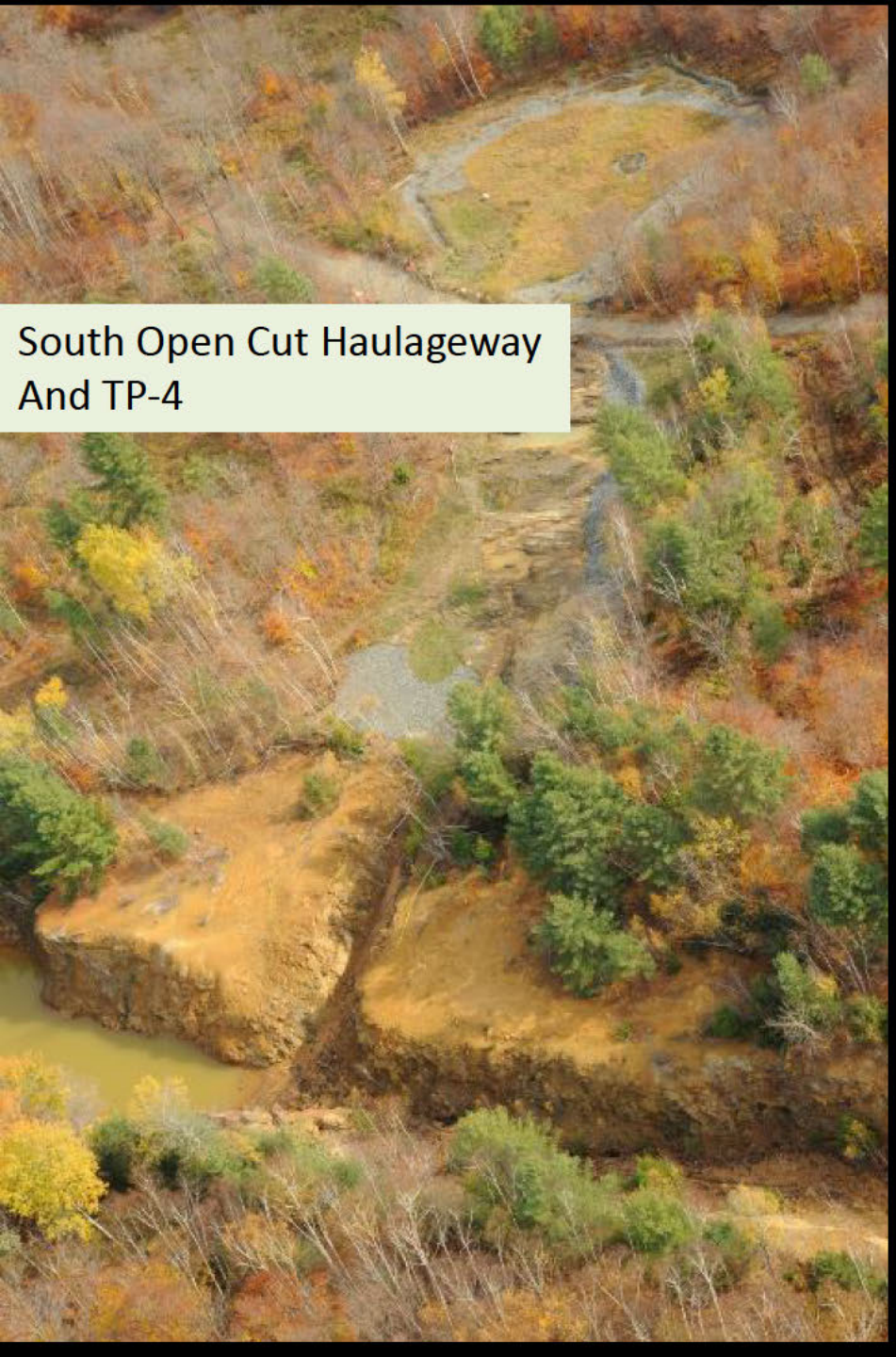
Phase 2 Remedial Action:
Lord Brook Source Areas
Description of Phase 2 Source Areas

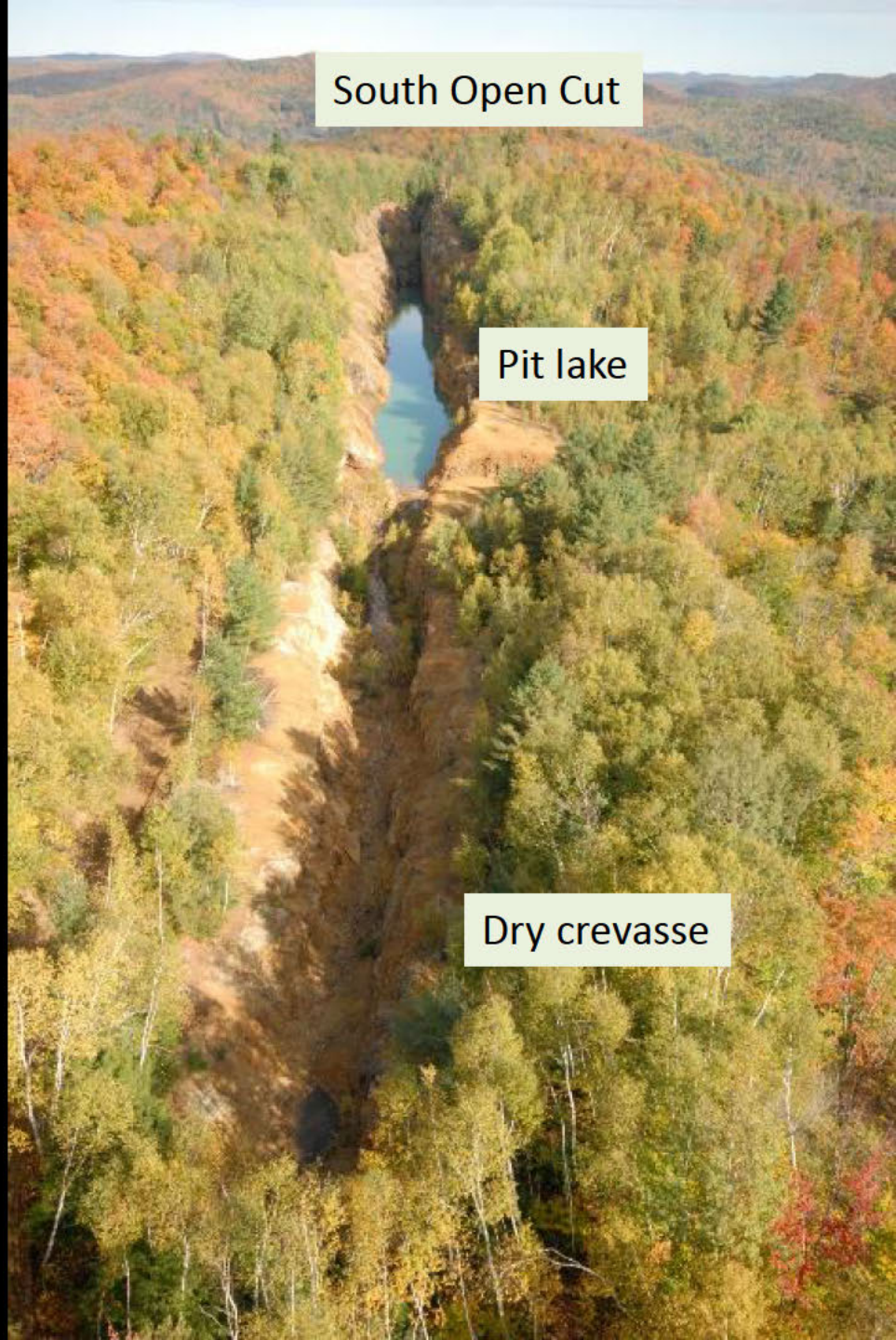
- South Open Cut
  - Bedrock excavation to supply ore for processing: 1950 – 1953
  - Pit lake created when surface water run-on and precipitation were allowed to accumulate after mining operation ceased.
  - 1,600 feet long, 50-100 feet wide
  - 1,100 foot long pit Lake with 3.6 million gallons of mine influenced water.
  - Discharges to a tributary of Lord Brook.
  - Unstable side walls due to dip angle.

Phase 2 Remedial Action:
Lord Brook Source Areas
Description of Phase 2 Source Areas

- South Mine
  - Bedrock excavation to supply ore for processing.
  - Operational period unknown, likely mid 1800's.
  - Pit lake created when surface water run-on and precipitation were allowed to accumulate.
  - 250 feet long and about 40 feet deep.
  - Drains to a small stream which is a tributary to Lord Brook

South Open Cut


South Open Cut Haulageway
And TP-4


South Open Cut
Pit lake
Dry crevasse

South Open Cut side wall is not stable

South Mine

South Mine
Pit lake

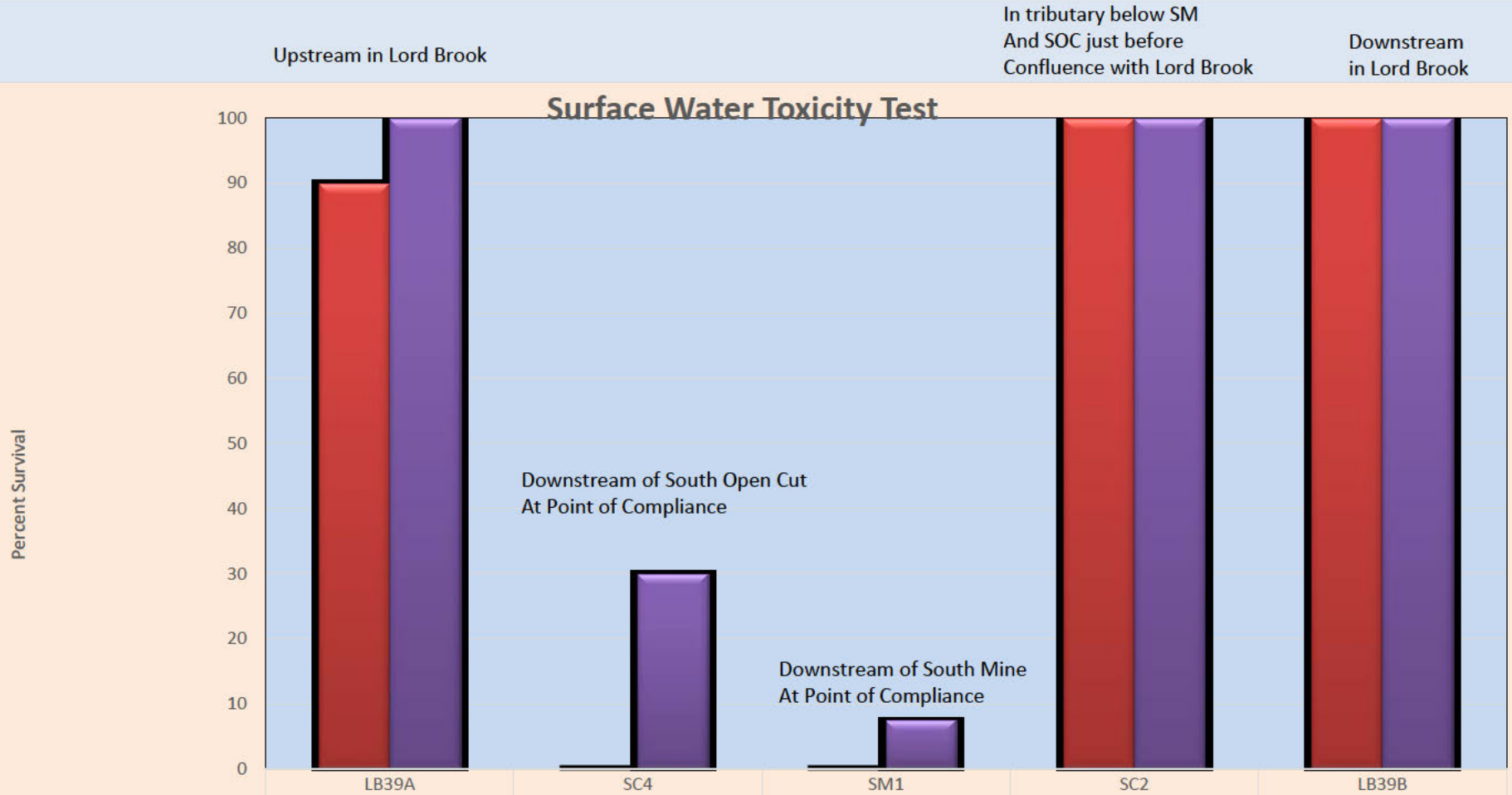
Phase 2 Remedial Action: Lord Brook Source Areas Summary of Ecological Threats

Assessment of Tributaries to Lord Brook that drain South Mine and South Open Cut.				Is surface water at this location toxic to aquatic organisms?		Is sediment at this location toxic to aquatic organisms?	
Tributaries to Lord Brook	Copper sediment concentration for 2013 toxicity testing (mg/l)	Average Copper surface water (ug/l)	Status of Benthic Community	acute toxicity	chronic toxicity	acute toxicity	chronic toxicity
SM1	2800	617	impaired	yes	yes	yes	yes
SC4	3300	104	impaired	yes	yes	yes	yes
SC2	880	30	impaired	no	no	no	yes

<u>Surface Water/Sediment Summary:</u>

- Surface water is toxic to aquatic organisms, benthic community is severely impaired, and several metals (copper, iron, and zinc) exceed water quality standards.

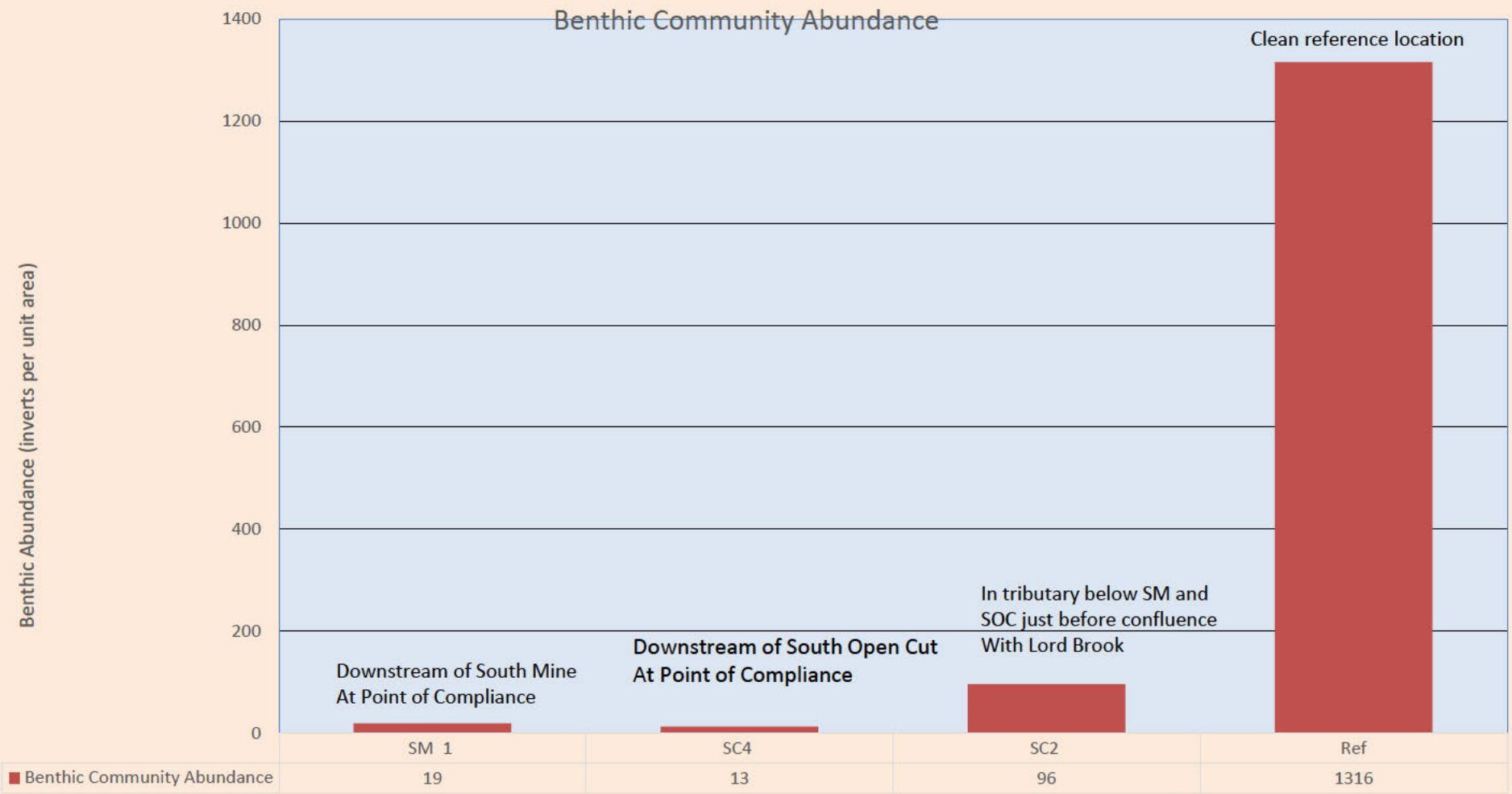
Phase 2 Remedial Action: Lord Brook Source Areas
Summary of Ecological Threats



	LB39A	SC4	SM1	SC2	LB39B
Percent survival c dubia	90	0	0	100	100
percent survival P. promelas	100	30	7.5	100	100

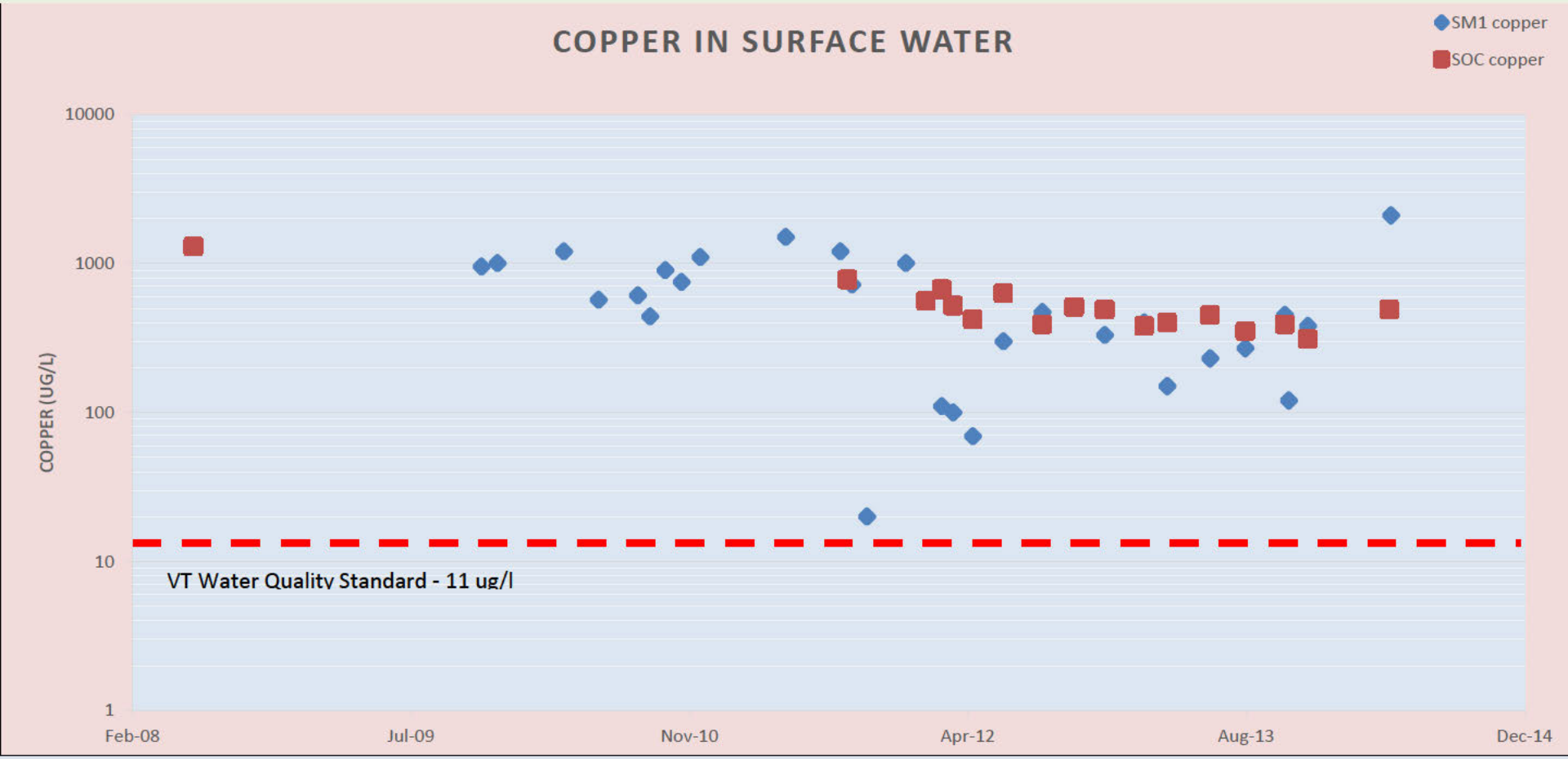
Surface toxicity testing documents complete mortality (100% of test organisms died for the c. dubia toxicity test) and substantial mortality (only 7.7% – 30% of the test organisms survived) for the surface water downstream of the South Mine and South Open Cut source areas. Several hundred feet of stream downstream of these sources is considered dead.

Phase 2 Remedial Action: Lord Brook Source Areas
Summary of Ecological Threats



The benthic community at the locations downstream of the South Mine (SM1) and the South Open Cut (SC4) is severely impaired when compared to a nearby reference stream. About 3,200 linear feet of stream are impaired based on the benthic community metric.

Phase 2 Remedial Action: Lord Brook Source Areas
Summary of Ecological Threats

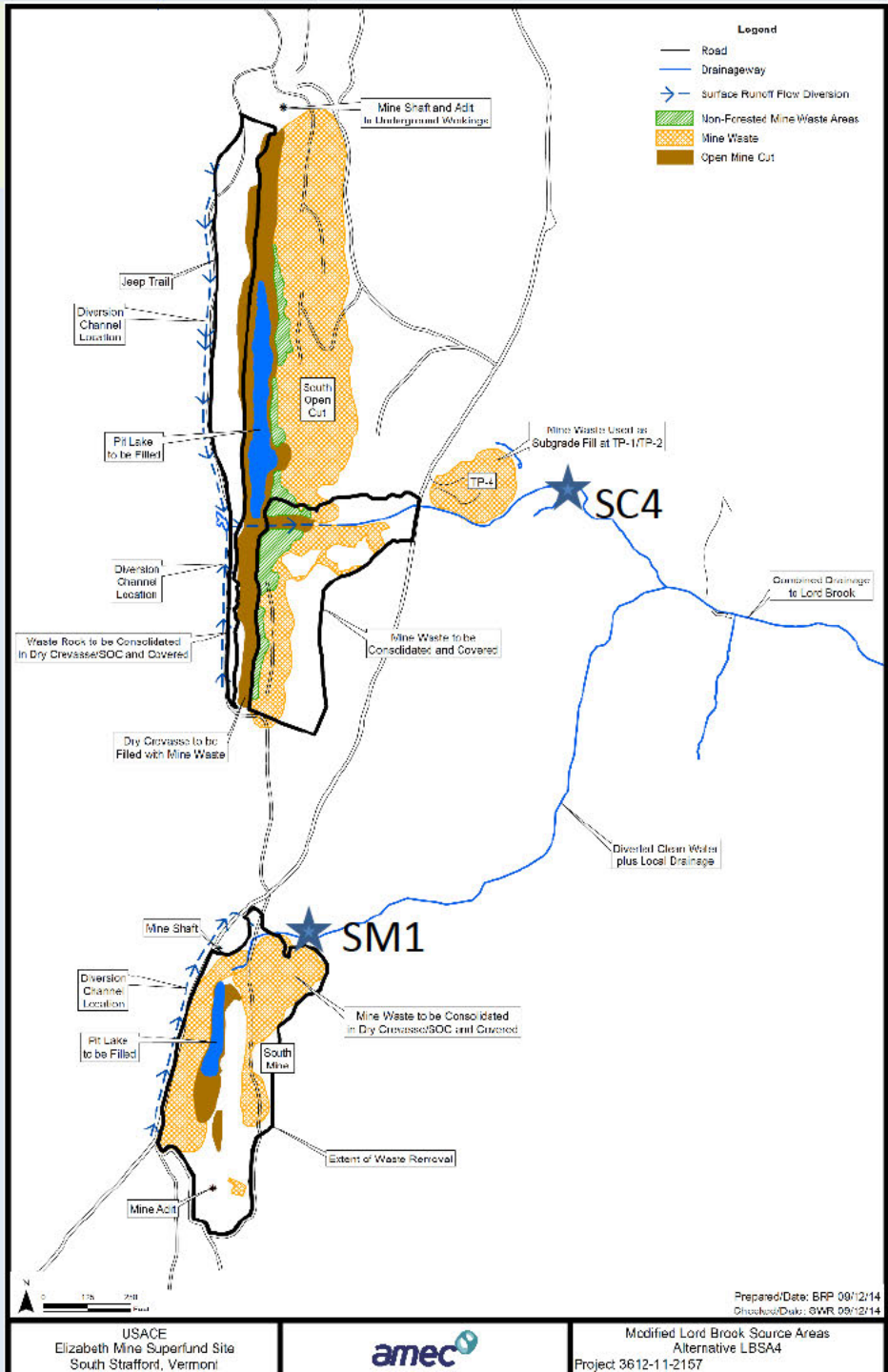


- Average copper concentrations in surface water discharging from South Mine pit lake are more than 50x and maximum concentrations are 190x the Vt standard for copper in the surface.
- Average copper concentrations in surface water from the South Open Cut are 9x and maximum concentrations are 25x the Vt standard for copper at the point of compliance.

Phase 2 Remedial Action: Lord Brook Source Areas
Clean Action Components

South Mine:

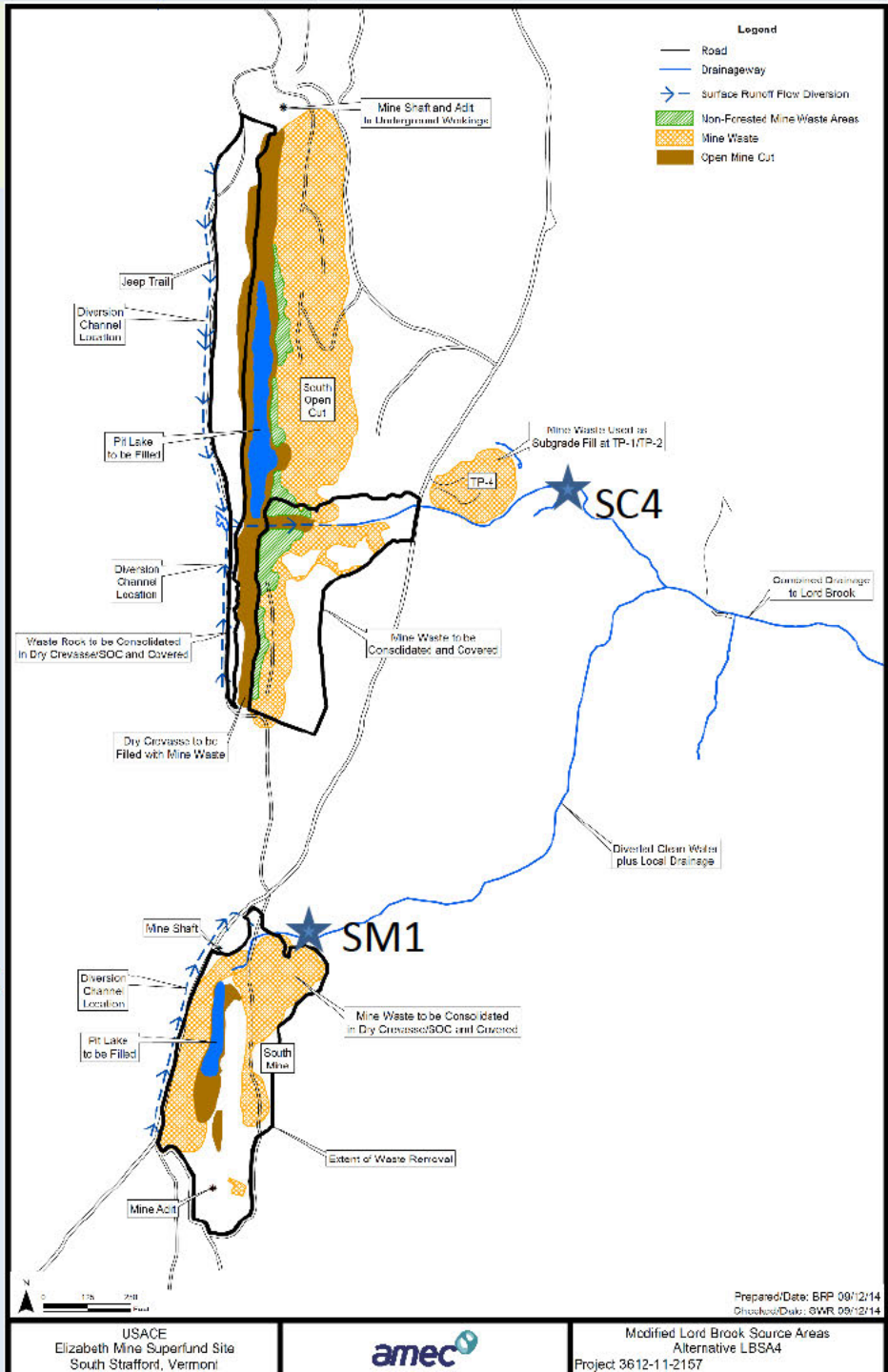
- Surface water diversion - about 750 linear feet of surface water diversion channels upgradient of South Mine;
- Treat and drain pit lake (pit lake holds 170,000 gallons of water);
- Eliminate pit lake with by filling with 900 cubic yards of material;
- Remove remaining acid generating soil/waste material for placement in South Open Cut or South Mine fill areas – estimated at 7,000 – 10,000 cubic yards;
- Vegetated soil cover over 3-4 acres of disturbed areas;
- Close abandoned shaft; and
- Wetland restoration.



Phase 2 Remedial Action: Lord Brook Source Areas
Clean Action Components

South Open Cut:

- Surface water diversion along upgradient side of South Open Cut – about 1600 linear feet;
- Treat and drain pit lake (pit lake holds 3.6 million gallons of water);
- Blast side walls and fill pit lake with about 52,000 cubic yards of material (mostly blasted wall rock);
- Fill and cover dry crevasse end of South Open Cut with about 20,000 cubic yards of material;
- Place 4 acre soil cover over former pit lake, dry crevasse, and consolidated waste rock adjacent to haulageway; and
- Restoration.



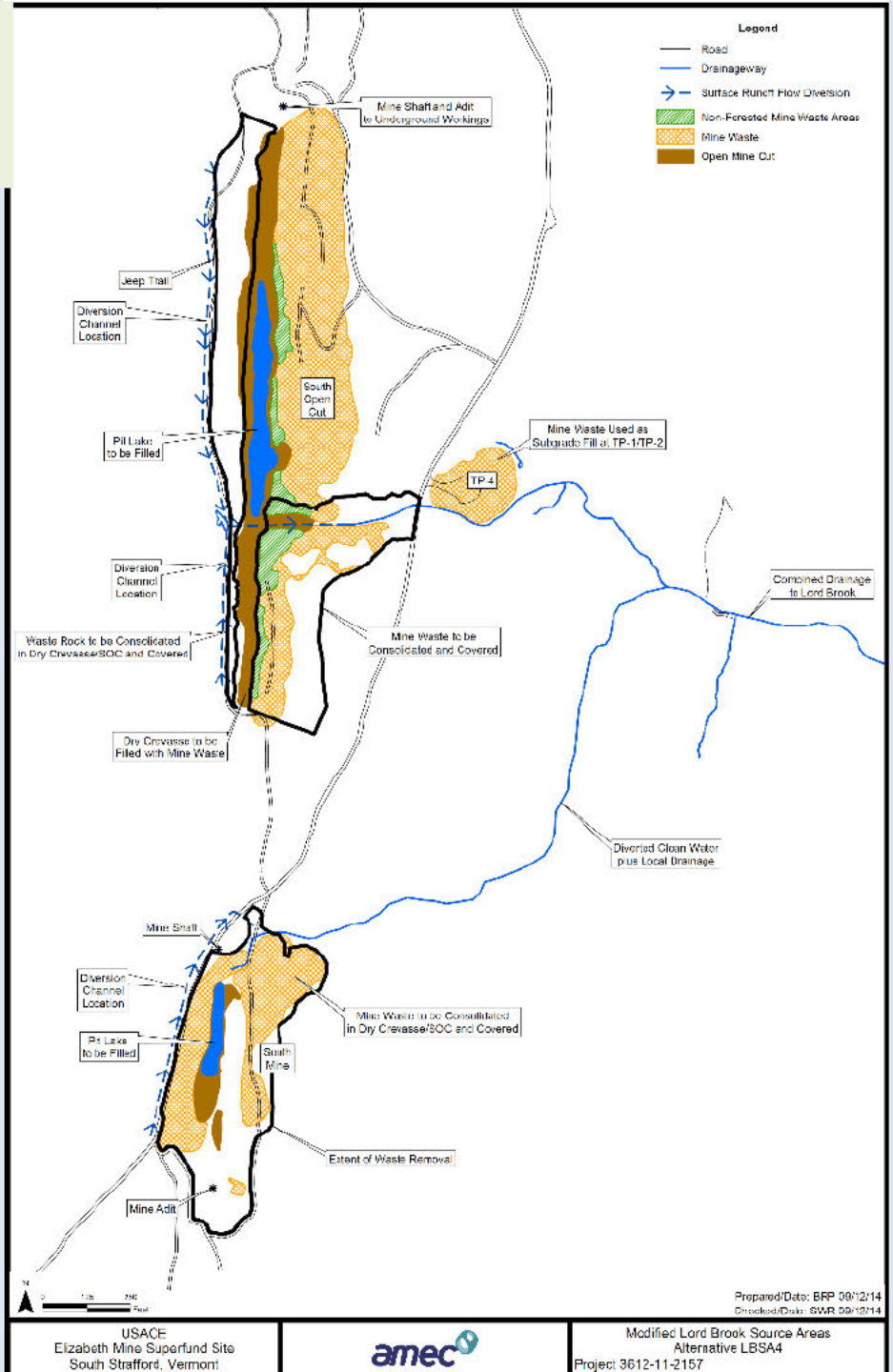
Phase 2 Remedial Action: Lord Brook Source Areas
Clean Action Components

Phasing:

- 1st construction season -South Mine and Dry Crevasse components of work.
- 2nd construction season-South Open Cut fill and site restoration.
- 3rd construction seasons – continued site restoration and punch list items.

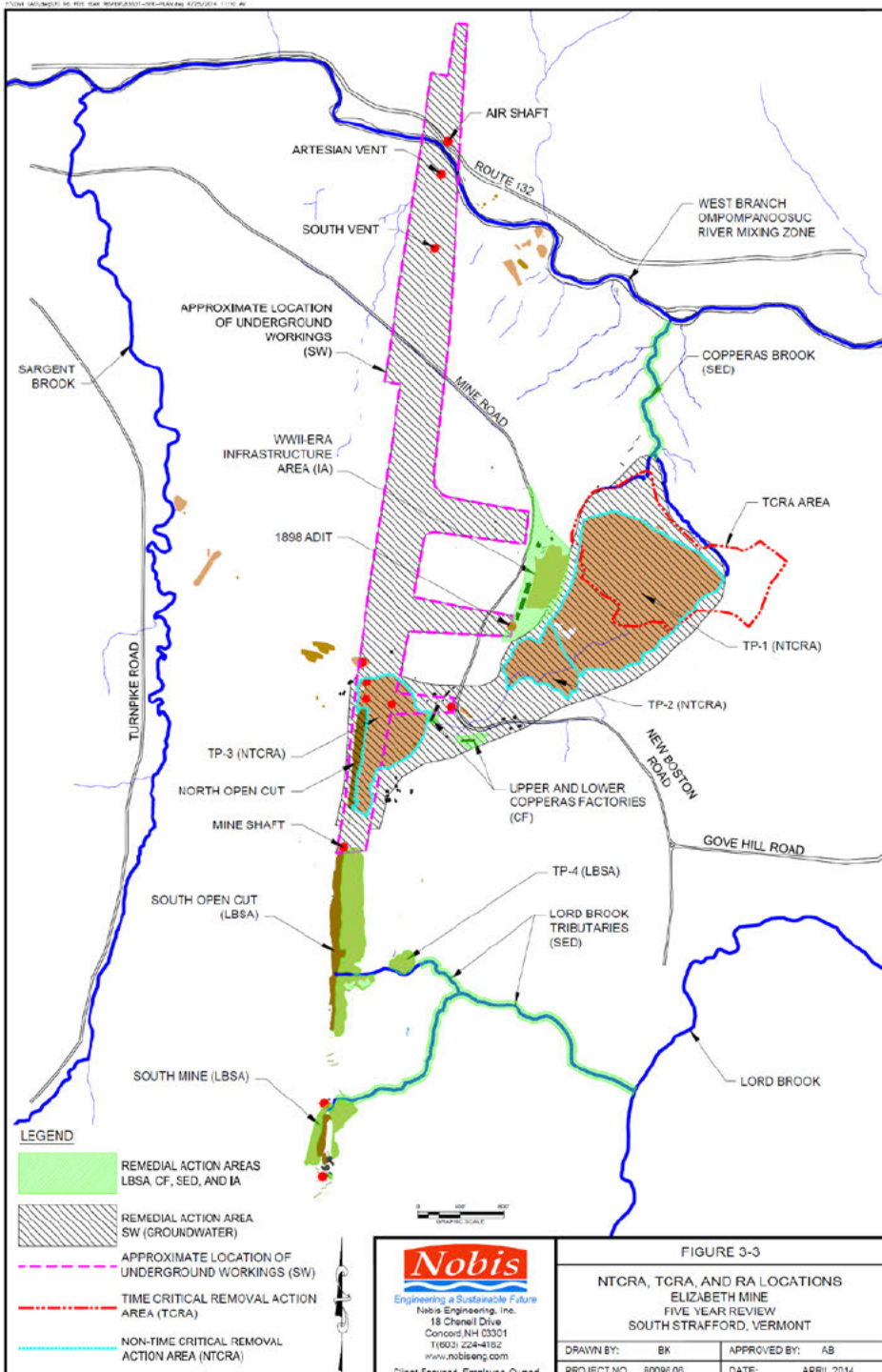
Estimated cost:

- Final RD Estimate is $10 million
- $5 million each year for 2 years



Remaining Cleanup Actions
Elizabeth Mine

Remaining Cleanup Action for Elizabeth Mine

- NTCRA Phase 3: Passive treatment system for TP-1 leachate to replace current water treatment system. Design complete. Awaiting leachate flow reduction to below 10 gallons per minute. Ongoing part of NTCRA.

- Phase 3 Remedial Action: Groundwater use restrictions, long-term monitoring, and site restoration. Design should be complete in 2016. Future panel submission.