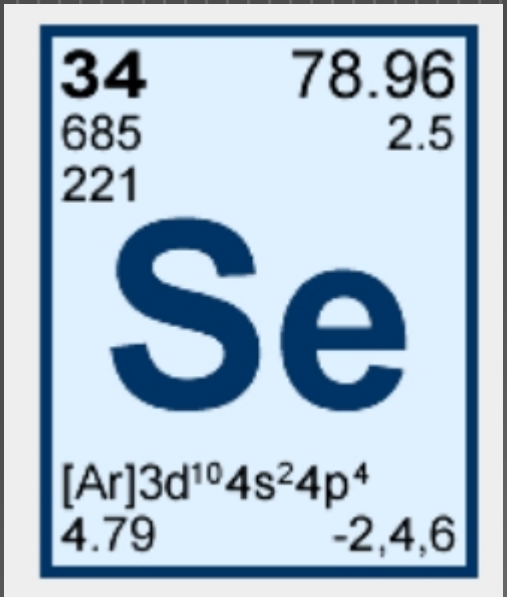


SELENIUM ASSESSMENT AND MANAGEMENT IN THE NORTH AMERICAN COAL MINING SECTOR: UNIQUE ASPECTS OF SETTING BENCHMARKS AND PROJECT DEVELOPMENT CONSIDERATIONS

OR

"EVERYTHING YOU ALWAYS WANTED TO KNOW ABOUT SELENIUM*

*But were afraid to ask."

Guy Gilron, MSc, RPBio

Senior Environmental Scientist

Borealis Environmental Consulting Inc.

Acknowledgements: Michael Patterson (AngloAmerican); Al Martin, Justin Stockwell (Lorax Environmental), Marko Adzic (Teck Resources), Stella Swanson (Swanson Strategies)

October 28, 2015

BOREALIS

ENVIRONMENTAL CONSULTING

PRESENTATION OVERVIEW

- Introduction
  - What is Selenium and Why is it different? What is at Issue?
- Selenium Assessment
  - Aquatic Life Criteria/Water Quality Guidelines
    - Canada
    - United States
    - Proposal for a Canadian Aquatic Life Guideline for Selenium – NAMC-SWG
- Selenium Management
  - General Considerations
  - Mine and Facility Design Considerations
  - An Adaptive Approach to Selenium Management
- Summary and Conclusions
- Questions?

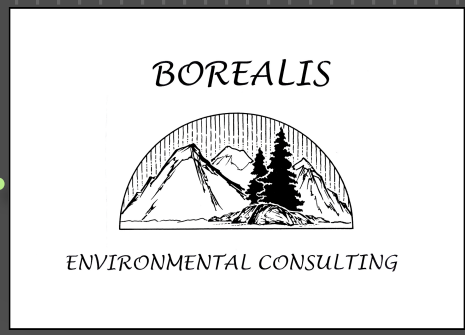
INTRODUCTION

A little about me…..

Guy Gilron, Borealis Environmental Consulting

- M.Sc., Marine Ecology, University of Guelph; Thesis: Plankton Ecology
- Registered Professional Biologist (R.P. Bio.) (British Columbia)
- 18 years environmental consulting (ON, BC) - ecotoxicology, environmental effects monitoring, ecological and human health risk assessment, First Nations consultation, regulatory liaison
- 9 years in the mining industry as Director, Environment (Teck) and VP Environment, Community and Regulatory Affairs (Cardero)
- Member, SETAC; Past-President of SETAC Laurentian
- Member, North American Metals Council – Selenium Working Group
- Member, Elk Valley Selenium Task Force (previously)
- Board of Directors, Canadian Ecotoxicity Workshop
- Editorial Board, *Integrated Environmental Assessment and Management*

A little about Borealis……

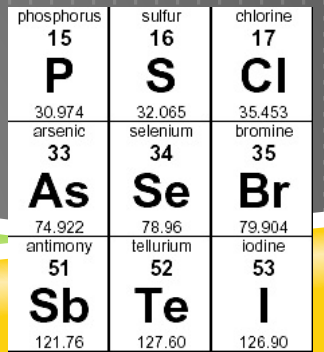


Borealis Environmental Consulting Inc.

- based in North Vancouver, BC; work with a variety of associates
- specialize in environmental impact and risk assessments, due diligence evaluations, for clients across industry sectors:
  - mining (metal and coal), oil and gas, chemical products
- recent work with various industry associations and multi-stakeholder forums, focus on the integration of science, policy, environmental management and regulatory decision-making
- expertise in the area of Selenium fate, effects, and management; work across North America

WHAT IS SELENIUM AND WHY IS IT DIFFERENT?

- Selenium (Se) – a naturally-occurring metalloid
- Increased [Se] have been monitored as a result of anthropogenic activities, e.g., mining, power generation, agriculture/animal husbandry
- Waste rock spoils associated with coal mining have the potential to increase leaching rates of Se, especially when it comes into contact with H_2O and O_2
- Essentiality/Toxicology:
  - essential for health of people, other animals, some plants (soils in BC deficient in Se)
  - in excess and in critical chemical species in diet can cause reproductive failures / abnormalities in egg-laying vertebrates (*i.e.*, fish, birds, amphibians, reptiles)
  - Reproductive/developmental effects likely due to Se replacing S in amino acid synthesis



WHAT IS AT ISSUE?

- Stakeholder concerns regarding elevated Se in effluent discharged from industrial operations (coal mines, specifically) has placed increased focus on Se assessment, mitigation and management
- Se is a complex chemical of concern which varies site-specifically:
  - potential effects are chronic, rarely acute
  - tissue threshold (of egg-laying vertebrates) vs. water concentration better correlate of effects
  - offspring of exposed individuals affected (not classic response)
  - lentic vs. lotic systems differ
- Dealing with Se must recognize the difference between existing and developing mines – reactive vs. proactive/preventative actions

This presentation: focus on considerations related to Se assessment and management during the project development phase

SELENIUM ASSESSMENT

AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES

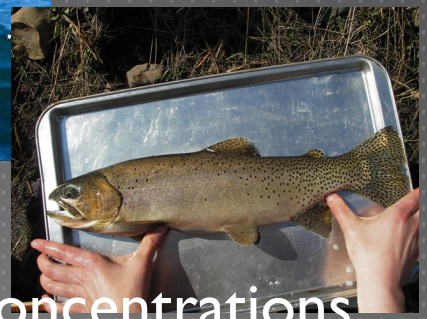
- Current State-of-Science
  - often in the primary literature, has not been incorporated into regulatory guidelines to keep up with science
  - based on chronic reproductive effects on 2nd generation fish/birds/amphibians
  - need to be based on controlled, long-term, chronic exposure, multi-generational lab experiments
  - criteria should be derived on tissue concentration basis

SETAC Pellston Workshop, 2009

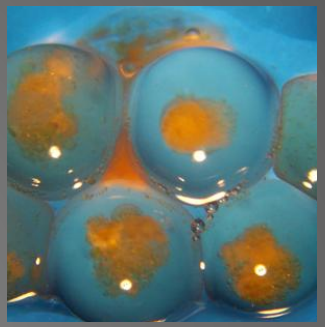
AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

- Hierarchy (less certain ---> more certain)

- Water Concentrations



- Whole Body/Muscle Tissue Concentrations



- Ovary/Egg Tissue Concentrations

AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

Canada

- National Guidelines – Canadian Council of Ministers of Environment (CCME)
- Provincial Guidelines – most default to CCME value, only BC has a 'different' guideline
- Canadian Nuclear Safety Commission (CNSC) – based on CCME, but currently applying tissue-based thresholds (where applicable/appropriate)

- Note: most guidelines derived using the Species Sensitivity Distribution (SSD) approach, not the Safety Factor (SF) approach (still used by BC)

SAFETY FACTOR METHOD VS. SSD APPROACH

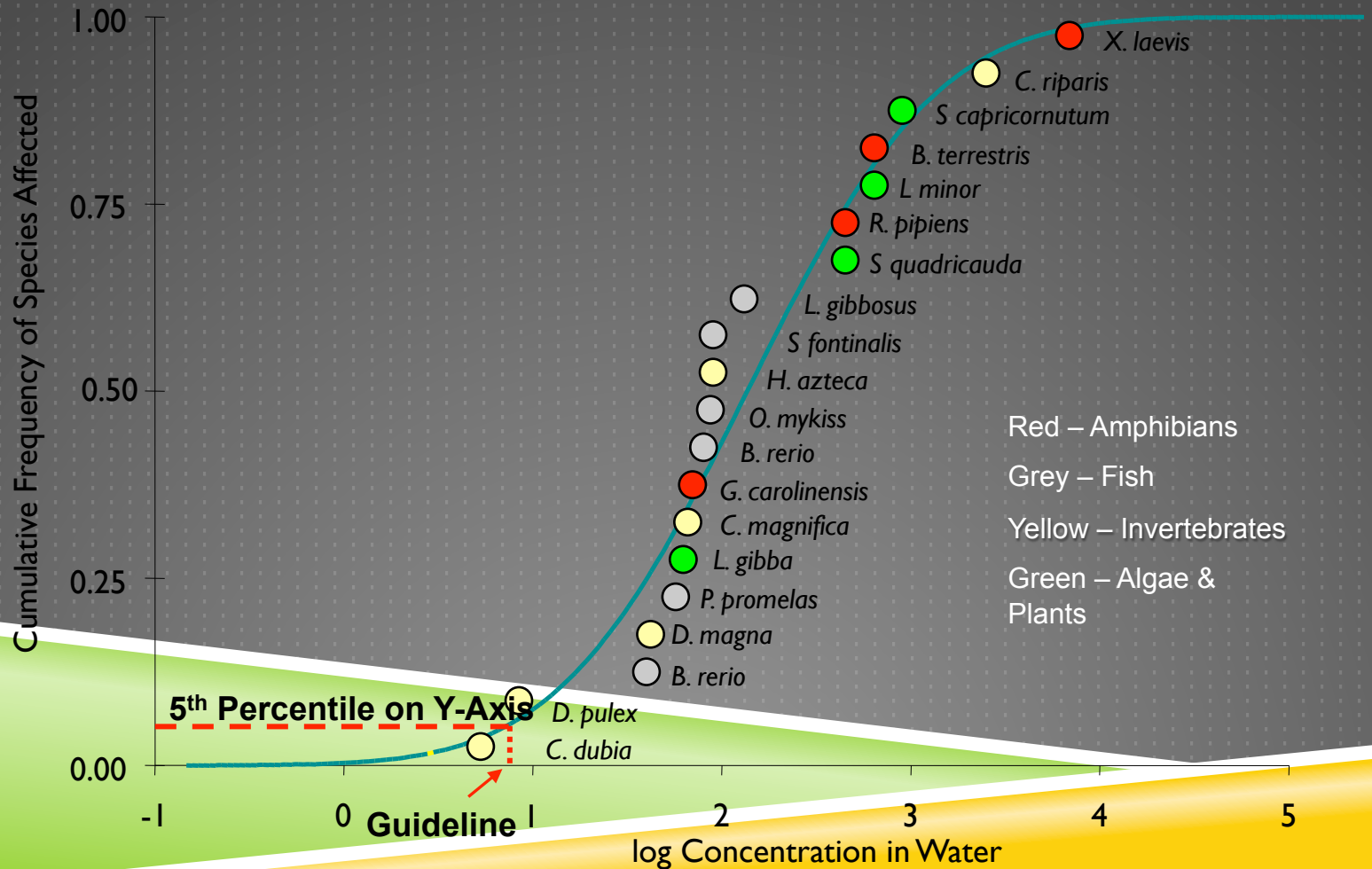
SAFETY FACTOR

- Guideline divided by an arbitrary safety factor
- Depends on type of key study (most based on one study)
- CCME Protocol (only when not enough data):
  - 10, 20, 100, etc.
  - (other jurisdictions: as above, and 1000, …)

- Extrapolation from the KNOWN (measured toxic impact) to the UNKNOWN (the protective threshold value)

SAFETY FACTOR METHOD VS. SSD APPROACH

SPECIES SENSITIVITY DISTRIBUTION (EXAMPLE)



AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

Canada

- historical basis for the current Canadian national (CCME) Se guideline - 1 µg/L to protect aquatic life
  - adopted from IJC (1981), for Great Lakes; published in CCREM (1987), "grandfathered" into CCME
  - based on field studies:
    - historical fish kills (Belews Lake/Hyco Reservoir), and not using traditional methods (*i.e.*, toxicity test data)
    - indicated that waterborne [Se] of 5-10 µg/L associated with food web "contamination" caused predatory fish mortalities

- no current plans for revision to current guideline, despite high profile of Se; more on this later……..

AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

British Columbia (2014)

Medium	Category	Previous (2001)	2014	Notes
Freshwater	Alert	N/A	1 μg/L	Not science-based (1/2 of guideline)
	Guideline	2 μg/L	2 μg/L	Based on SF approach (not SSD)
Dietary (Invertebrate tissue)	INTERIM	N/A	4 μg/g (dw)	Weight of evidence; lowest published thresholds, no UF applied; insufficient data for full guidelines.
Sediment	INTERIM	2 μg/g (dw)	2 μg/g (dw)	
Tissue (fish)	Egg/Ovary	N/A	11 μg/g (dw)	SSD derived = 20 μg/g (dw) (DeForest *et al.*, 2012)
	Whole Body	4 μg/g (dw)	4 μg/g (dw)	50% of Draft USEPA criterion

AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

United States

- States:
  - Utah (2011; based on bird egg tissue)
  - Kentucky (2013; tiered approach)
  - West Virginia, Colorado, others pending, awaiting USEPA
- National/Federal
  - USEPA (DRAFT) – currently in expert & public review

AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

Utah (2011) – based on water bird tissue (eggs) dw for Great Salt Lake

- < 5.0 mg/kg: dw — routine monitoring with sufficient intensity to determine if [Se] within the Great Salt Lake ecosystem are increasing.
- 5.0 mg/kg: dw — increased monitoring to address data gaps, loadings, and areas of uncertainty identified from initial Great Salt Lake Se studies.
- 6.4 mg/kg: dw — Initiation of a Level II Anti-degradation review by the State for all discharge permit renewals or new discharge permits to Great Salt Lake (may include an analysis of loading reductions).
- 9.8 mg/kg: dw — Initiation of preliminary TMDL* studies to evaluate selenium loading sources.
- > 12.5 mg/kg: dw — Declare impairment. Formalize and implement TMDL*.

*TMDL=total maximum daily load

AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

Kentucky (2013) – based on [water] and [fish tissue], uses a tiered approach

- Step/Tier 1. Water column Se_{total} concentration > 5.0 μ g/L threshold?
  - if [water column] for Se_{total} is ≤ 5.0 μ g/L the water body is meeting its aquatic life use.
  - if [water column] for Se_{total} is > 5.0 μ g/L, proceed to Step/Tier 2.

- Step/Tier 2. Site is in attainment of fish tissue criterion? (i.e., whole body [8.6 μ g/g Se_{total} dw] or egg/ovary tissue [19.3 μ g/g Se_{total} dw]).
  - if each species-composite fish tissue has concentration < the appropriate tissue-based criterion, water body meets chronic standard.
  - if a species-composite fish tissue has concentration exceeding tissue criterion, the site is considered in non-attainment of the water quality standard.

AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

U.S. EPA – 2015 (2nd DRAFT; Public Comment period closed)

Medium	Category	Previous (Interim)	Proposed (2015?)
Freshwater	Lentic (slow-moving waters)	5 μg/L	1.2 μg/L
	Lotic (fast-moving waters)	5 μg/L	3.1 μg/L
Tissue (fish)	Whole Body	7.91 μg/g (dw)	8.0 μg/g (dw)
	Muscle Tissue	N/A	11.3 μg/g (dw)
	Egg / Ovary	N/A	15.8 μg/g (dw)

PROPOSAL FOR A CANADIAN AQUATIC LIFE GUIDELINE FOR SELENIUM

- Overview of the North American Metals Council - Selenium Work Group (NAMC-SWG)
  - Industry-funded, engaged in technical research on issues pertaining to Se (NOTE: not exclusive to metal mining)
  - Activities include:
    - sharing of information on Se impacts, guidelines/criteria, mitigation, and treatment technologies
    - development of Se effects thresholds, water quality tissue-based standards
    - identification of field programs and analytical methods

- As part of its ongoing efforts, the NAMC-SWG develops papers on these topics and shares them publicly:

  http://www.namc.org/selenium.html

PROPOSAL FOR A CANADIAN AQUATIC LIFE GUIDELINE FOR SELENIUM

- History of Initiative
- 2008: CCME Subcommittee of NAMC-SWG established
  - direct and coordinate research aimed at developing/deriving a Third-Party Contributed Guideline force consideration.
- 2009: BCMOE provided an update regarding Se WQG revision; CCME likely to consider a provincial guideline over a Third-Party Contributed Guideline, should Se be prioritized for guideline revision.
- Subsequently:
  - NAMC-SWG continued with initiative
  - BCMOE developed a revised guideline document (now finalized, and published)

PROPOSAL FOR A CANADIAN AQUATIC LIFE GUIDELINE FOR SELENIUM

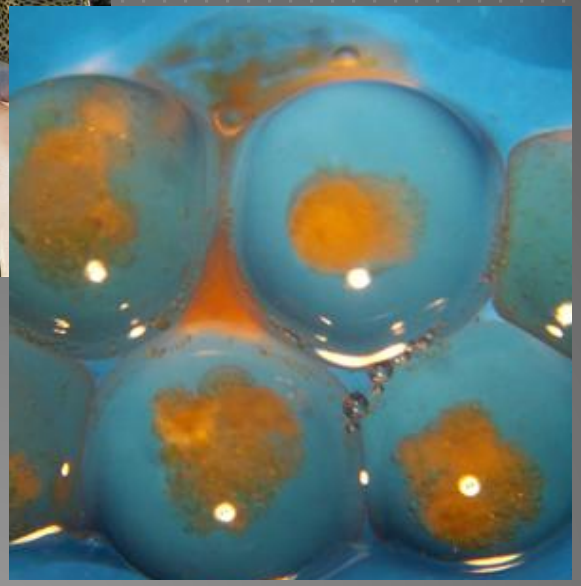
- History of Initiative, cont'd.
  - How could NAMC-SWG work to contribute to CCME's future revision of a freshwater aquatic life guideline for Se?
  - BC Se guideline based on the "Safety Factor" approach (not used by CCME, when there are sufficient data).
  - CCME – and most other international jurisdictions - recommends the Species Sensitivity Distribution (SSD) approach in the development of WQGs.

PROPOSAL FOR A CANADIAN AQUATIC LIFE GUIDELINE FOR SELENIUM

- Summary of Work Completed to Date
  - Phase I - Development of a tissue-based threshold, developed according to CCME protocols (DeForest *et al.*, 2012).
  - Phase II - Derivation of a water-based guideline, 'back-calculated' from the tissue-based guideline, using data generated by project team, and using statistically-derived bioaccumulation factors (DeForest *et al.*, 2015; *in press*).

PHASE I

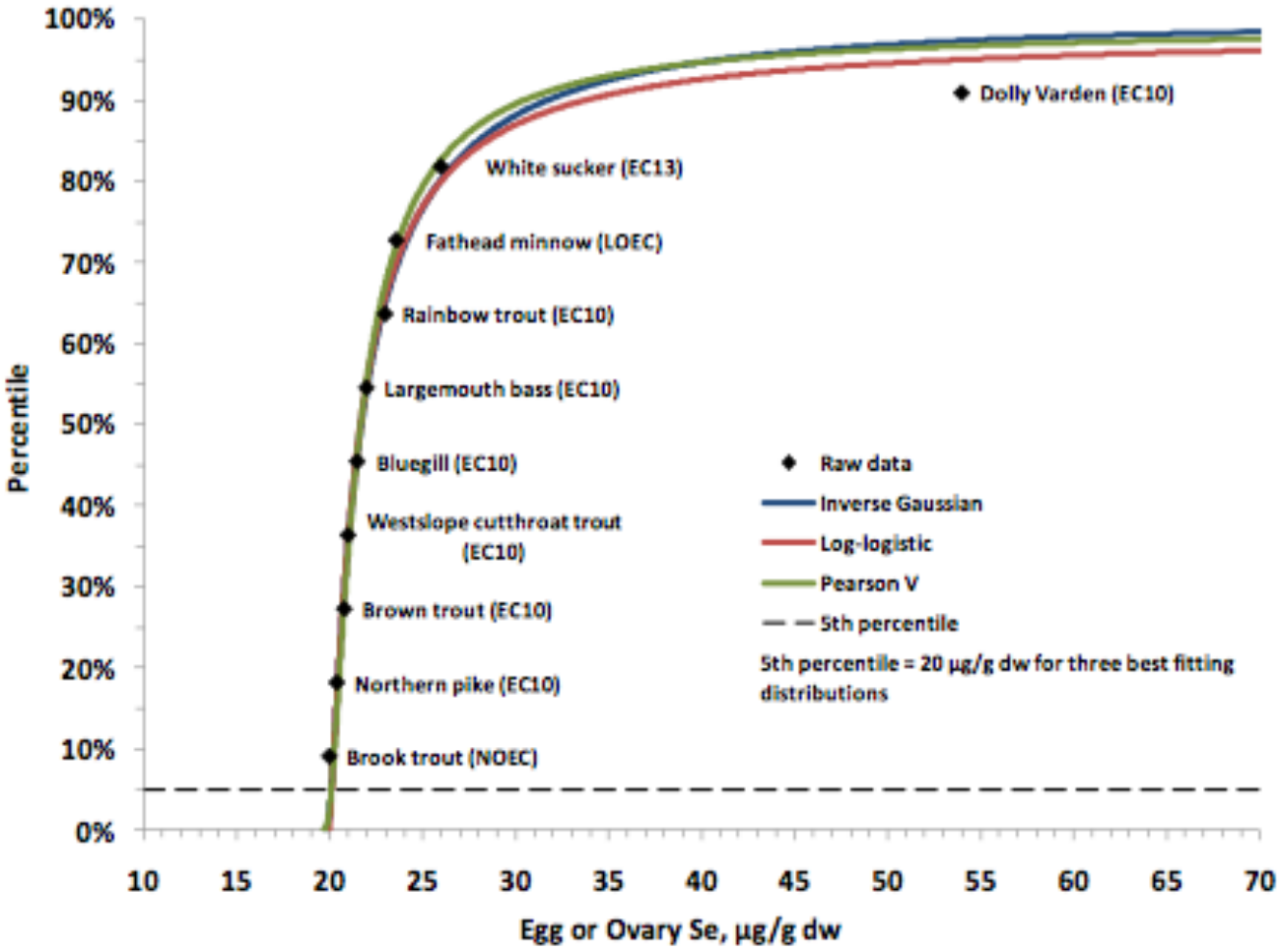
- Development of a tissue-based threshold



SELENIUM TISSUE-BASED WQG BASED ON THE SSD APPROACH

- Used CCME toxicity endpoint hierarchy:
  - EC_{10} > $EC_{11\text{-}25}$ > MATC > NOEC > LOEC > $EC_{26\text{-}49}$ > nonlethal EC_{50}
- SSDs developed for:
  - all species, Canadian species, Canadian "coldwater" species, excluding "uncertain" thresholds (*i.e.*, brook trout, white sucker)
- Sensitivity Analysis:
  - Regardless of data set (above), 5th percentile of SSDs = 20 µg/g dw
- Paper published in *IEAM* journal in June 2012:
  - DeForest, D., Gilron, G., Armstrong, S., and Robertson, E. 2012. Species Sensitivity Distribution (SSD) Evaluation for Selenium in Fish Eggs: Considerations for Development of a Canadian Tissue-based Guideline. *Integrated Environmental Assessment and Management.* 8(1) 6-12.

Figure 1. Species sensitivity distributions (SSDs) based on all egg or ovary Se toxicity thresholds for fish species that occur in Canada. See Table 1 for sources of toxicity thresholds.



DeForest *et al.*, 2012

PHASE II

- Derivation of a water-based guidelines

Table 1. Summary of possible waterborne selenium screening guidelines from the approaches evaluated.

Approach	Description	Water Se (µg/L)	
		Lotic or Selenate	Lentic or Selenite
Quantile regression	Field-based water-to-particulate Se data	6.5	3.0
	Laboratory-based water-to-particulate selenate or selenite data[1]	5.1	1.5
	Pooled laboratory selenate/field lotic and laboratory selenite/field lentic	4.7	1.9
	Mean of all quantile regression approaches:	5.4	2.1

[1] Assuming that selenate data are representative of lotic conditions and selenite data are representative of lentic conditions.

DeForest *et al.*, 2015

SE WQG PROPOSED TIERED APPROACH

Water Screening Guideline:
Lentic (2.1 µg/L*) and Lotic (5.4 µg/L*)

Below?

No Se Toxicity

Above?

Fish Tissue Guideline 20 µg/g dw**

Below?

No Se Toxicity

Above?

Se Toxicity Potential

*total Se
**egg/ovary

AQUATIC LIFE CRITERIA / WATER QUALITY GUIDELINES, CONT'D.

U.S. EPA (2nd DRAFT) 2015 vs. NAMC-SWG (DeForest *et al.*, 2012, 2015)

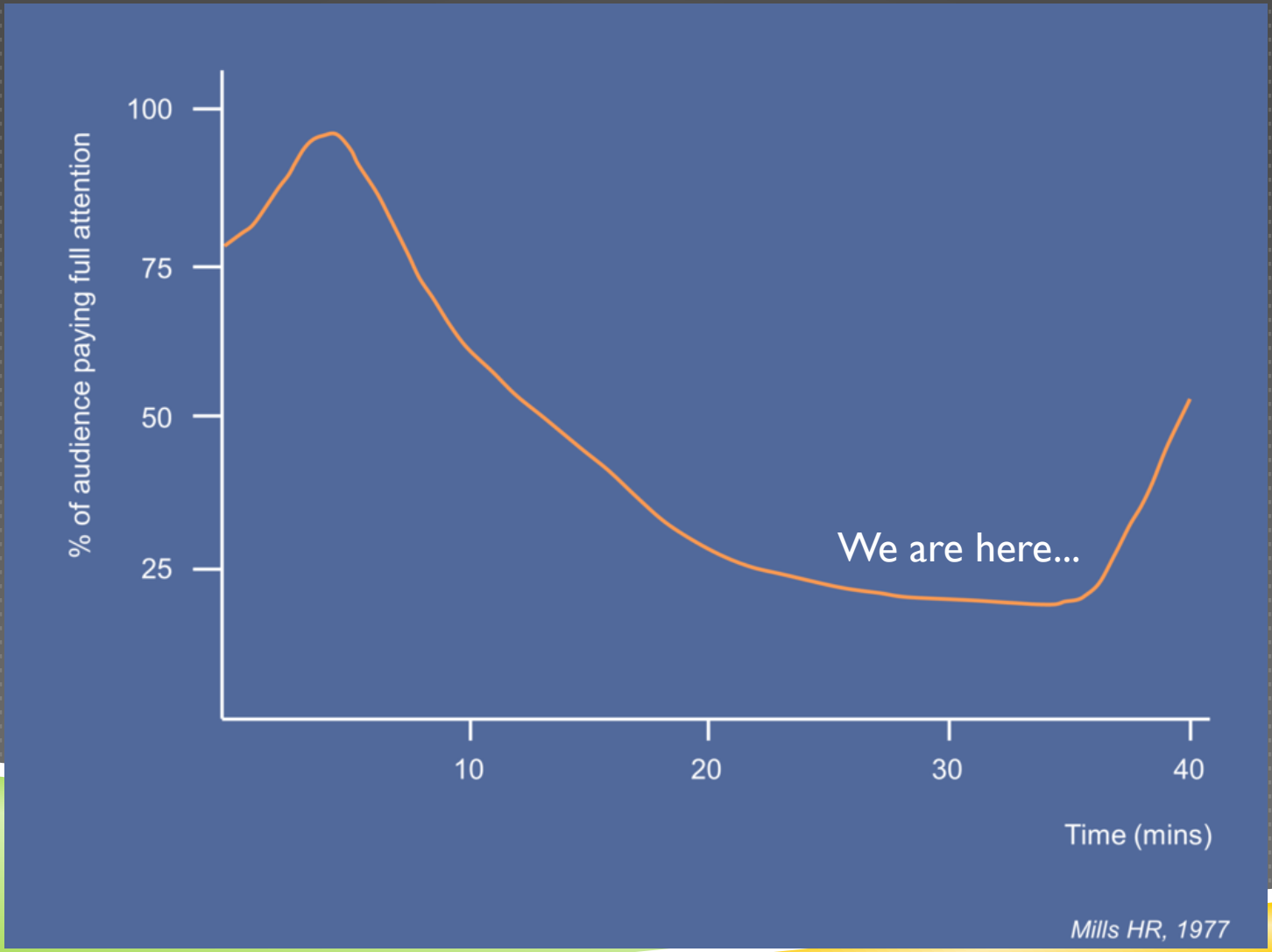
Medium	Category	Previous	USEPA DRAFT (2015)	DeForest *et al.* 2012 (IEAM) DeForest *et al.*, 2015 (EST)
Freshwater	Lentic (slow moving)	5 μg/L	1.2 μg/L	2.1 μg/L
	Lotic (fast moving)	5 μg/L	3.1 μg/L	5.4 μg/L
Tissue (fish)	Whole Body Muscle Tissue	7.91 μg/g (dw) N/A	8.0 μg/g (dw) 11.3 μg/g (dw)	N/A
	Egg / Ovary	N/A	15.8 μg/g (dw)	20 μg/g (dw) – based on extensive bioaccumulation studies

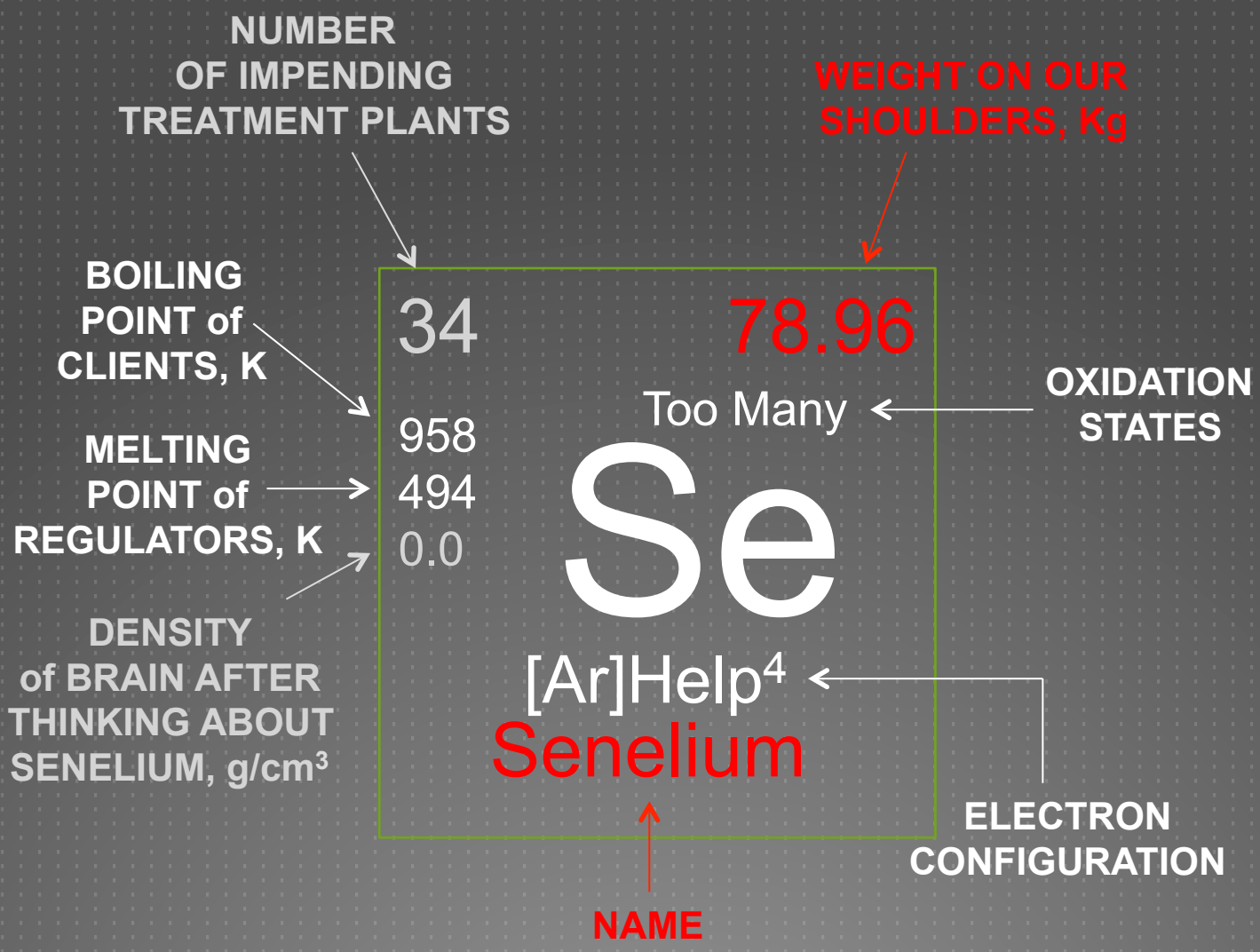
NEXT STEPS

- NAMC-SWG:
  - requesting consideration of a Third-Party Contributed Guideline [revision] for Se.
  - contacting provincial representatives in order to obtain a "champion/sponsor" for this initiative.

- Guidelines Development Project Team of the CCME Water Management Committee
  - consider need for revision of the current Se Guideline for the Protection of Aquatic Life (Freshwater) (*i.e.*, 1 μg/L)

INTERMISSION





"Senelium"

(səˈnē lē əm): Noun: from Latin *senilis*, to be driven crazy!

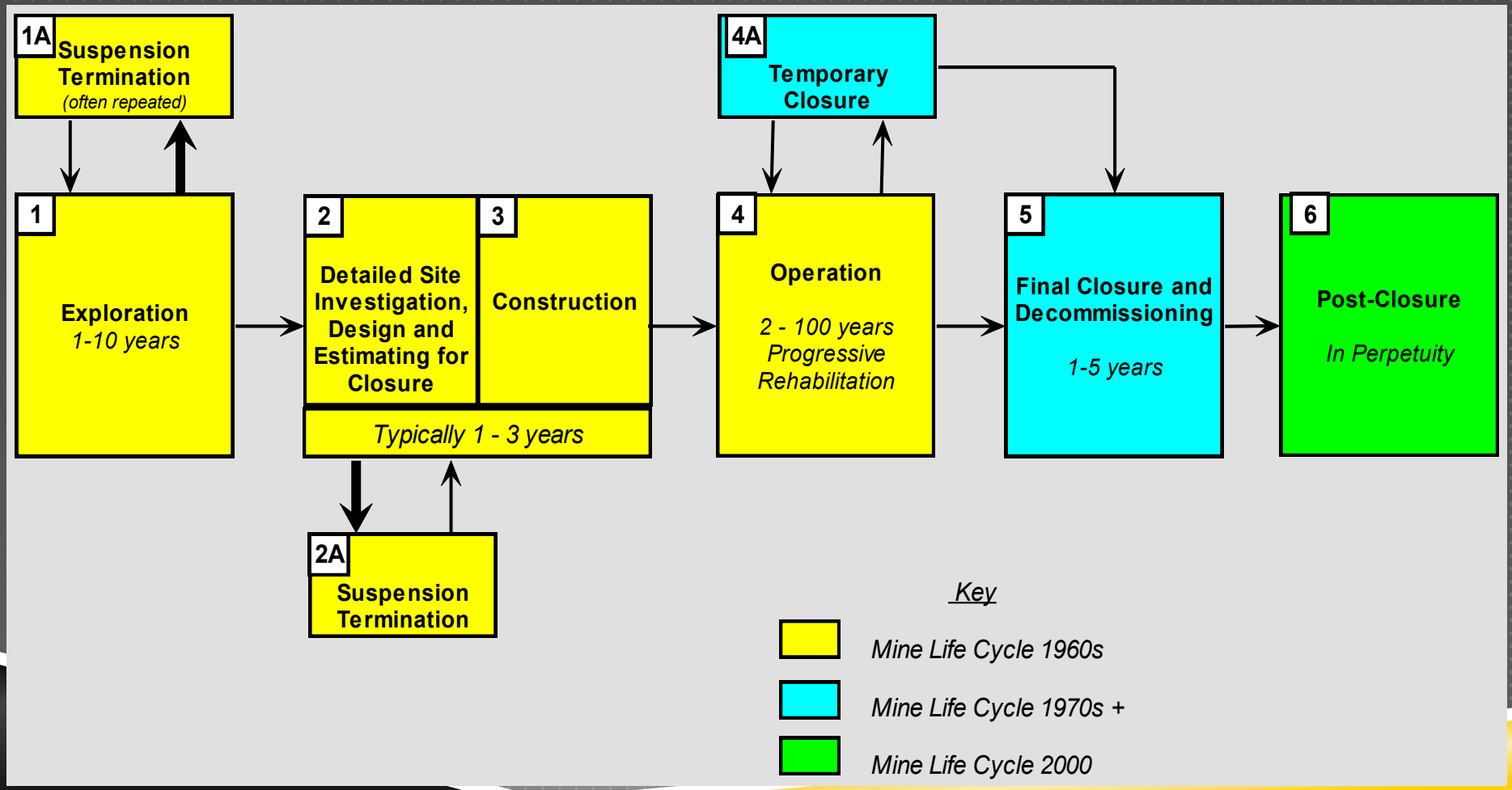
Back to Sleep!

SELENIUM MANAGEMENT

GENERAL CONSIDERATIONS

- Where does Se assessment/management fit into coal mine project development?
- The Mining Life Cycle
  - Project Development in context
- Project Development Phases:
  - Exploration and Mine Planning
  - Environmental Assessment and Permitting
  - Construction

The Mining Life Cycle



* Thanks to Ian Thomson, On Common Ground

GENERAL CONSIDERATIONS - CONT'D.

- Where does Se assessment/management fit into coal mine project development? – cont'd.
- Project Development Phases:
- Exploration and Mine Planning (NI 43-101 – compliant)
  - Preliminary Economic Assessment (PEA)
  - Pre-Feasibility Study (PFS)
  - Bankable Feasibility Study (BFS)*

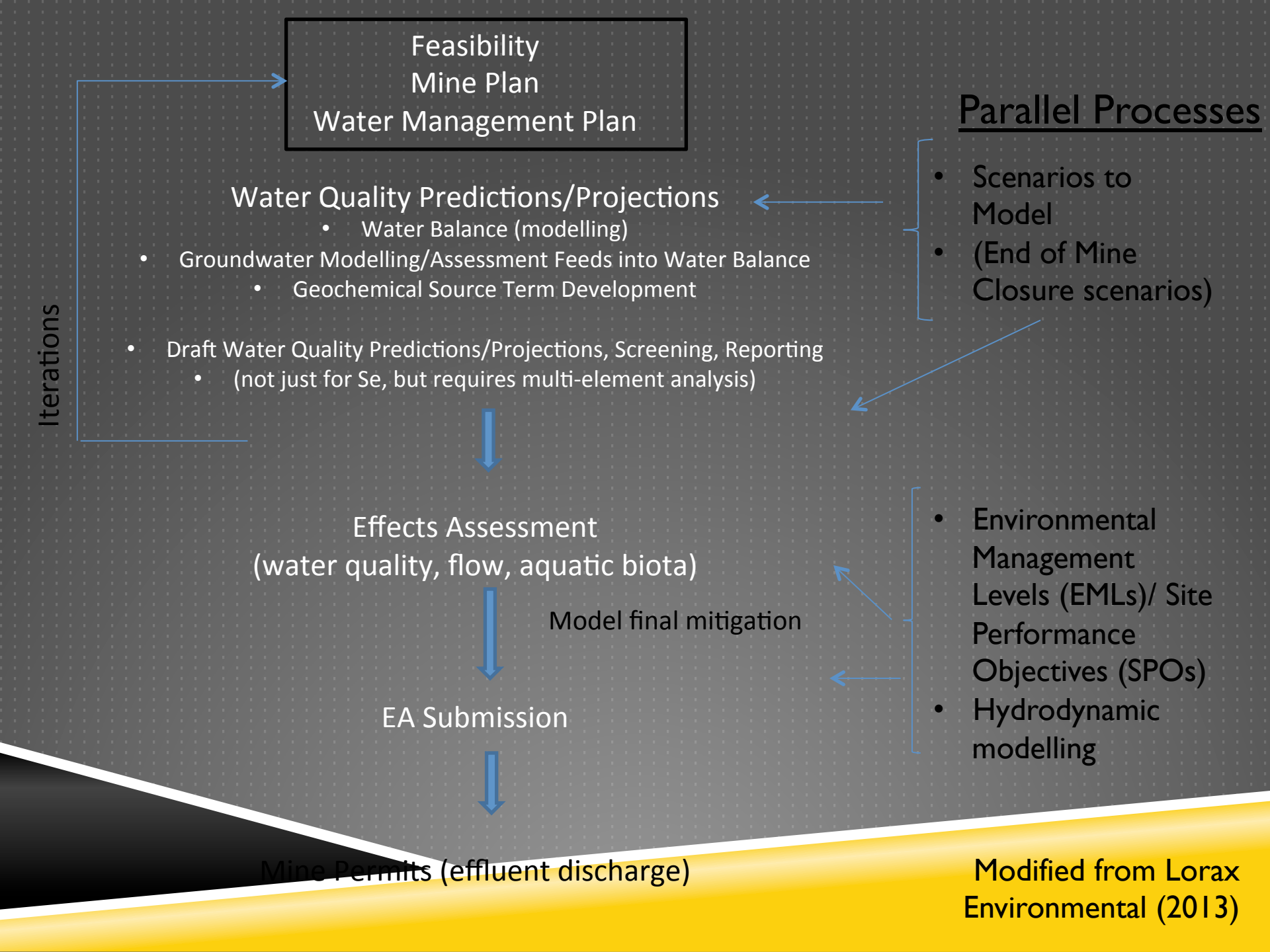
GENERAL CONSIDERATIONS - CONT'D.

- Project Development Phases, cont'd.:
  - Environmental Assessment and Permitting*
    - Environmental Assessment Report (and Certificate)
      - Based on an comprehensive EA (incl. baseline studies, effects assessments and management plans – to deal with impact mitigations)
    - Permitting
      - permits related to discharge (air, water)
      - *Mines Act* Permit (BC) – including reclamation bonding.

Note: EA and Permitting often initiated prior to BFS

SELENIUM IN ENVIRONMENTAL ASSESSMENT – KEY ELEMENTS

- Baseline studies
  - **Hydrology/Limnology** – climate, design events, flow
  - **Hydrogeology** – groundwater flow, quality
  - **Geochemistry** – 'source terms' from waste rock
  - **Water quality** – receiving environment, predicted effluent quality
  - **Fish/Aquatic Biota** – ecological receptors
- Effects Assessment
  - Water Balance, Aquatic Effects Assessment (including assimilative capacity)
  - Ecotoxicity Evaluations/ Modelling/Risk Assessment
  - Human Health
- Management Plan(s)
  - Water Management Plan
  - Se Management Plan
  - Environmental Management System


Feasibility
Mine Plan
Water Management Plan
Iterations
Water Quality Predictions/Projections
• Water Balance (modelling)
• Groundwater Modelling/Assessment Feeds into Water Balance
• Geochemical Source Term Development
• Draft Water Quality Predictions/Projections, Screening, Reporting
• (not just for Se, but requires multi-element analysis)
Parallel Processes
• Scenarios to Model
• (End of Mine Closure scenarios)
Effects Assessment
(water quality, flow, aquatic biota)
Model final mitigation
EA Submission
Mine Permits (effluent discharge)
• Environmental Management Levels (EMLs)/ Site Performance Objectives (SPOs)
• Hydrodynamic modelling
Modified from Lorax Environmental (2013)

SELENIUM ASSESSMENT / MANAGEMENT KEY ELEMENTS

- ***Engage*** early with applicable regulatory agencies
  - e.g., Environment, Mines, Natural Resources, DFO
- ***Understand*** stakeholder concerns
  - What are communities and FNs concerned about? How can concerns be addressed?
- ***Establish*** appropriate benchmarks, thresholds
  - Are EMLs/SPOs appropriate due to site-specificity? Will regulators accept these?
- ***Ensure*** that predictions/projections are based on current/recent, best available, quantitative information
  - What is the quality of baseline data? How can uncertainty be reduced?

SELENIUM MANAGEMENT CONSIDERATIONS

- ***Understand*** the assimilative capacity of receiving environment
  - What is the size of the Initial Dilution Zone (IDZ)?
  - What impact does dilution have on [Se] in receiver?
- ***Research*** available technologies to assure their efficacy
  - How will full-scale treatment plant deal with final effluent volumes? How efficient will a treatment system be?
- ***Evaluate*** cost-benefit of any/all technologies
  - Design for in-stream concentrations (vs. traditional 'end-of-pipe')

MINE AND FACILITY DESIGN PRINCIPLES

- Ensure that "clean"* water is kept clean
  - Optimize the volume of water reused and recycled on site
  - Minimize clean water coming into contact with waste rock, coarse coal refuse
- Ensure aquatic effects assessment results (e.g., water quality predictions, water balance) feed back to mine design engineers early in FS → water management diversions and structures (e.g., sedimentation ponds)

* "Clean" = not impacted by on-site activities

MINE AND FACILITY DESIGN PRINCIPLES – CONT'D.

- Progressive Reclamation throughout life of mine – standard practice
- Maximize potential use of:
  - innovative design and siting of waste rock dumps
  - backfilling (above ground, underground)
  - end pit lakes (surface)

Overall……."Design for Closure"

AN ADAPTIVE APPROACH TO SELENIUM MANAGEMENT

- The Adaptive Approach:
  - Throughout the EA and Permitting phase(s), need to consider various options so as to anticipate the various potential outcomes of aquatic effects assessment (impacts and mitigations)
  - "Fine-tune" as you go through EA and permitting

AN ADAPTIVE APPROACH TO SELENIUM MANAGEMENT – CONT'D.

- Option 1. No constraints, mitigations unnecessary
- Option 2. Diversion of mine-influenced waters
- Option 3. On-site utilization of affected waters ('Reuse and Recycle')
- Option 4. Active management of mine-influenced waters
- Option 5. *In situ* treatment
- Option 6. Active treatment

AN ADAPTIVE APPROACH TO SELENIUM MANAGEMENT – CONT'D.

- **Option 1. No constraints, mitigations unnecessary**
  - Based on geochemical source terms (from static and kinetic tests), water quality modelling predictions, overall water balance
  - This option would be based on [Se] not exceeding applicable risk thresholds such as:
    - generic aquatic life criteria (e.g., BCMOE, CCME, USEPA)
    - Site Specific Water Quality Objectives (SSWQO) – existing mines
    - Environmental Management Levels (EMLs)/Site Performance Objectives (SPOs) – developing mines
      - Latter two – based on multi-generational toxicity tests and/or bioaccumulation modelling; requires monitoring to validate
  - In all cases, need to consider the potential for elevated background concentrations

AN ADAPTIVE APPROACH TO SELENIUM MANAGEMENT – CONT'D.

- **Option 2. Diversion of mine-influenced waters**
  - Based on the principle that clean water is diverted from waste water
  - In cases of moderate Se exceedances of the above-mentioned risk thresholds (e.g., an order of magnitude), mine-influenced waters could be diverted from sedimentation ponds located at various points on the property to:
    - non-fish bearing waters
    - waters of low habitat quality
      - [reduces risk to potential receiving water receptors]
  - This option may require habitat compensation

AN ADAPTIVE APPROACH TO SELENIUM MANAGEMENT – CONT'D.

- **Option 3. On-site utilization of affected waters ('Reuse and Recycle')**
  - Se-impacted waters may be suitable for use on site for activities such as:
    - Coal washing and processing in a Coal Handling and Processing Plant (CHPP)
    - Dust suppression on roads and stockpiles
  - In the case that partial or full treatment is implemented, this option reduced the volume of discharge water to be treated

AN ADAPTIVE APPROACH TO SELENIUM MANAGEMENT – CONT'D.

- **Option 4. Active management of mine-influenced waters**
  - The release of Se-impacted waters could be restricted by the assimilative capacity of the receiving environment
  - Active management, through the use of water storage and timed release could be used to match site loads with assimilative capacity of the receiver.

AN ADAPTIVE APPROACH TO SELENIUM MANAGEMENT – CONT'D.

- **Option 5. *In situ* / passive treatment**
  - In cases whereby [Se] in effluent would be significantly higher than those discussed above (*i.e.*, nearing 2 orders of magnitude)
  - A number of *in situ* treatment approaches can be considered, including: passive systems (bioreactors)/*in situ* treatment approaches (*e.g.*, engineered wetlands).

AN ADAPTIVE APPROACH TO SELENIUM MANAGEMENT – CONT'D.

- **Option 6. Active treatment**
  - Also in cases where [Se] in effluent would be significantly higher than those discussed above (*i.e.*, nearing 2 orders of magnitude)
  - Active treatment technologies – either total or partial - may to be considered, depending on:
    - (a) the magnitude of [Se] above benchmarks; and,
    - (b) the volume of water requiring treatment.

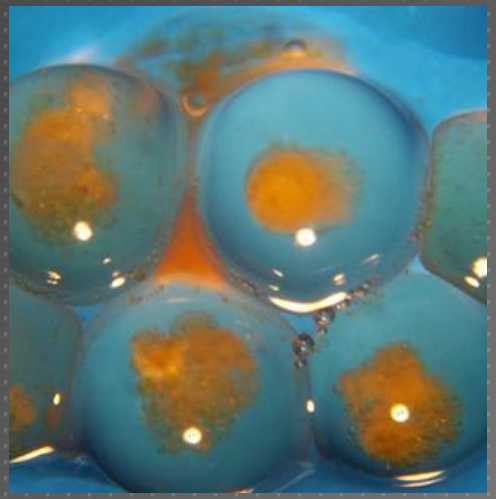
SUMMARY AND CONCLUSIONS

- Se – unique characteristics, unique regulations/ guidelines
  - challenge of keeping guidelines current with rapidly-changing science
- 2014/2015 – the year of changing Aquatic Life guidelines/regulations?
    - BC (finalized; 2014)
    - USEPA (draft; 2015)
      - {note: Health Canada just revised DWQG from 10 to 50 ppb}
- NAMC Proposal for new CCME Guideline (Canada)
  - News to follow……..

SUMMARY AND CONCLUSIONS

- Recently, greater focus on the potential effect(s) of Se in effluent discharged from coal mines (mostly in North America)
- Se is a complex chemical of concern; site-specific issues (site receptors, lentic vs. lotic receiving waters) need to be considered
- Coal mines going through project development have an opportunity to proactively assess, mitigate and manage Se using a range of tools, including mine design parameters, mitigation principles and treatment technologies
- There are a number of mitigation/management options to be considered using an adaptive approach

THANK YOU



34 78.96
685 2.5
221
Se
[Ar]3d¹⁰4s²4p⁴
4.79 -2,4,6

QUESTIONS?