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Intergenerational Cost-Estimates: Challenges and Solutions for Long-Term Cleanup Decision Making

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Agenda

- The challenge with long-term cost estimates
- Current practices, and what guidance tell us
- Survey of decision documents with long-term cleanup time
- The economics of long-term cost estimating
- Case study involving one long-term cleanup
- Conclusions and recommendations for preparing long-term cleanup cost estimates

The challenge with long-term cost estimates

- The easy sites have been cleaned up; we are left with the most-complex sites
  - NRC estimates 12,000 complex sites still require cleanup, of 126,000, and $209 billion needed to cleanup (EPA 2004)
- A greater percentage of organizations' remediation budgets are allocated to long-term O&M
- RI/FS guidance (1988) did not consider the intergenerational possibility of cleanup
  - we were quite optimistic about time of remediation
- "Stakeholders may question the practice of discounting costs over 30 years, because even after 30 years, someone is still responsible for managing sites that have not reached unlimited use and unrestricted exposure". (ITRC, 2017)

Guidance in Discount Rates for Cleanup

Guidance Source	Recommended Rate	Timeframe	Comments
1988 RI/FS (EPA)	5% after inflation and before taxes	Generally not longer than 30 years	Sensitivity of 3 and 10 percent
1993 OMB Circular A-94 (supersedes 1972 guidance)	7% “real” discount rate	Not specified	Rate approximates marginal pre-tax ROR in private sector in recent years
2000 FS (USACE)	For >30 years, include a “no-discounting” scenario, but for comparison only	For projects > 30 years	Complies with USEPA Policy

Survey of decision documents with long-term cleanup time

Site	Date	Time or Remediation (years)	ROD Basis
Paducah, KY	1995	1900	30 yrs
Hanford 200 West	2012	150	150 yrs @ 2%
Hunterstown, PA	1993	Inestimable (DNAPL)	30 yrs
Naval Air Development Center, PA	1997	Inestimable	30 yrs
Waterloo, IA	2004	> 100 yrs	30 yrs
West Site, ME	2002	35-1000 years	30 yrs
Rodale, PA	1999	Inestimable	30 yrs
Anniston, AL	2011	1,233 - > 10,00 years	NA - FS basis
NASA Santa Susanna Field Laboratory (SSFL), CA	Pending	35-380 years (area dependent)	N/A – CMS basis

The economics of long-term cost estimating

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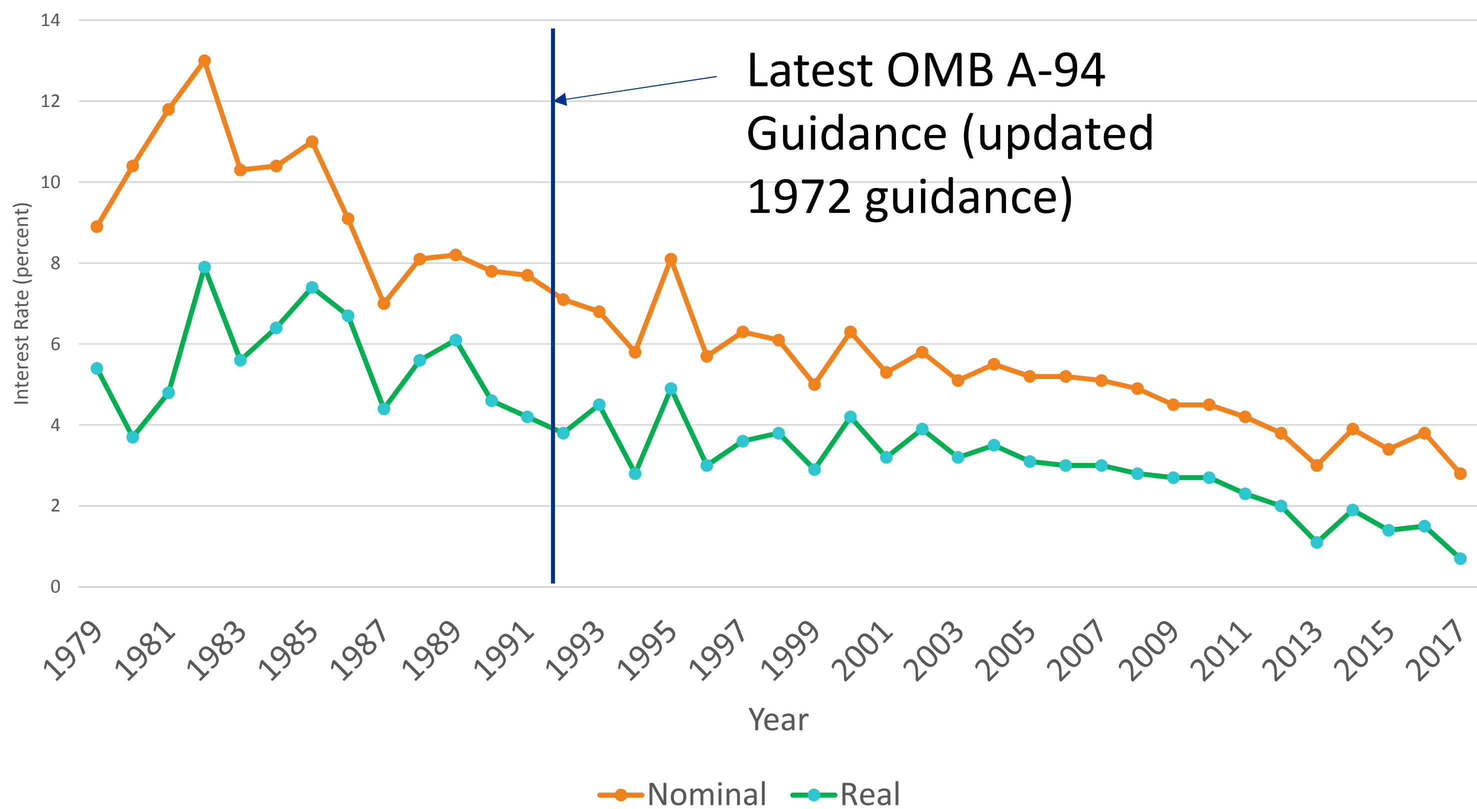
From Investopedia!

- The **nominal interest rate** is conceptually the simplest type of interest rate. It is simply the stated interest rate of a given bond or loan.
- The **real interest rate** is so named because it states the “real” rate that the lender or investor receives after inflation is factored in; that is, the interest rate that exceeds the inflation rate
- Discounting accounts:
  - for changes in time
  - rate at which consumption changes
  - rate at which marginal value of consumption changes
  - rate at which the future utility from consumption in discounted with time
- It’s really hard to predict for long time horizons

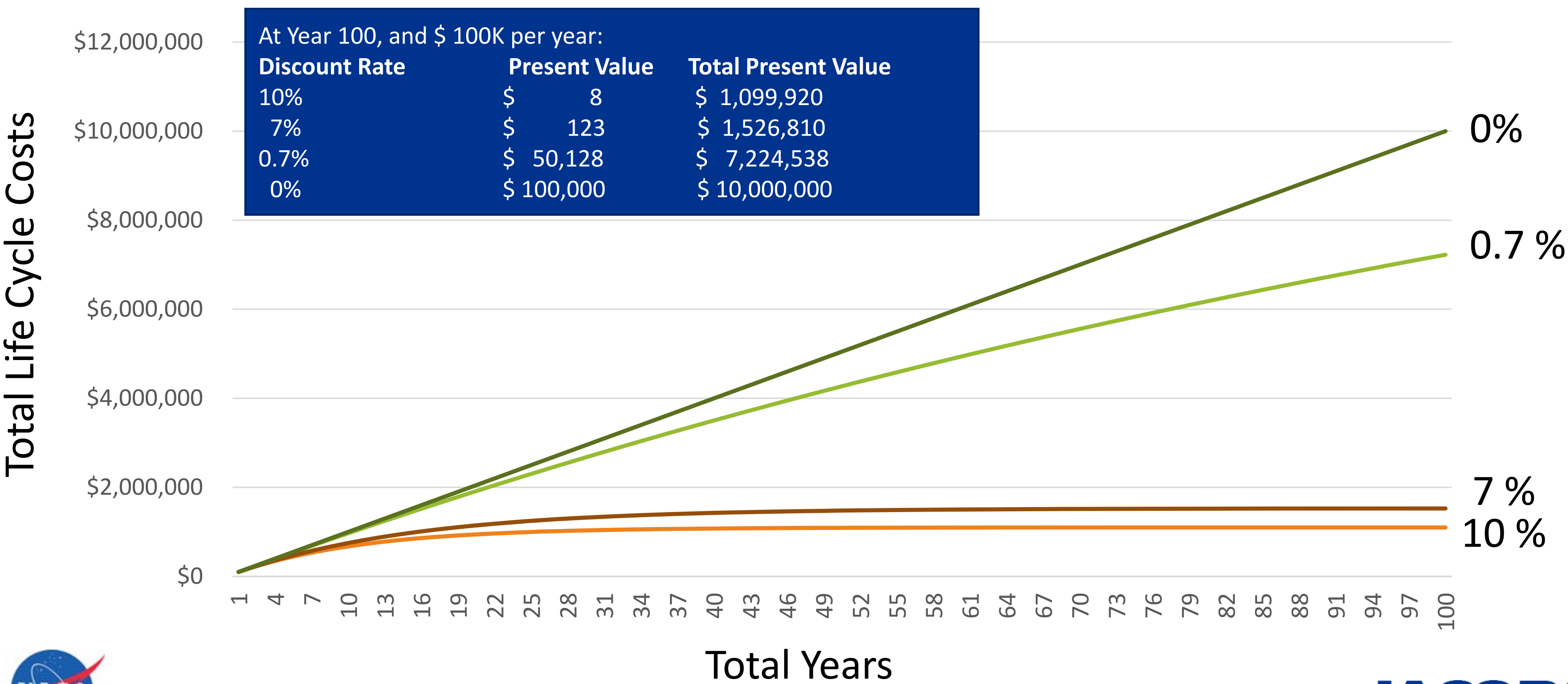
Change in Nominal and Real Interest Rates for Treasury Bonds (30-year basis)



PV for Four Different Discount Rates Over 100 Years
Would Decisions Change with Different Rates?

At Year 100, and $ 100K per year:

Discount Rate	Present Value	Total Present Value
10%	$ 8	$ 1,099,920
7%	$ 123	$ 1,526,810
0.7%	$ 50,128	$ 7,224,538
0%	$ 100,000	$ 10,000,000



Key Economic Considerations

- Current guidance (EPA, 1992) on discount rates calls for:
  - 7% for Federal Jobs
  - Higher for private jobs (sometimes more than 10%)
  - The use of real interest rates may apply if all alternatives result in the same value
- Discounting is essential for short- and medium- term private financial decisions (assess investment versus return)
- The higher the rate, the lower the PV cost
- There is an implicit assumption that money will be available in the future for this specific project when it is needed – not always the case
- For Superfund projects, states do not want to take on long-term O&M after 10-year period

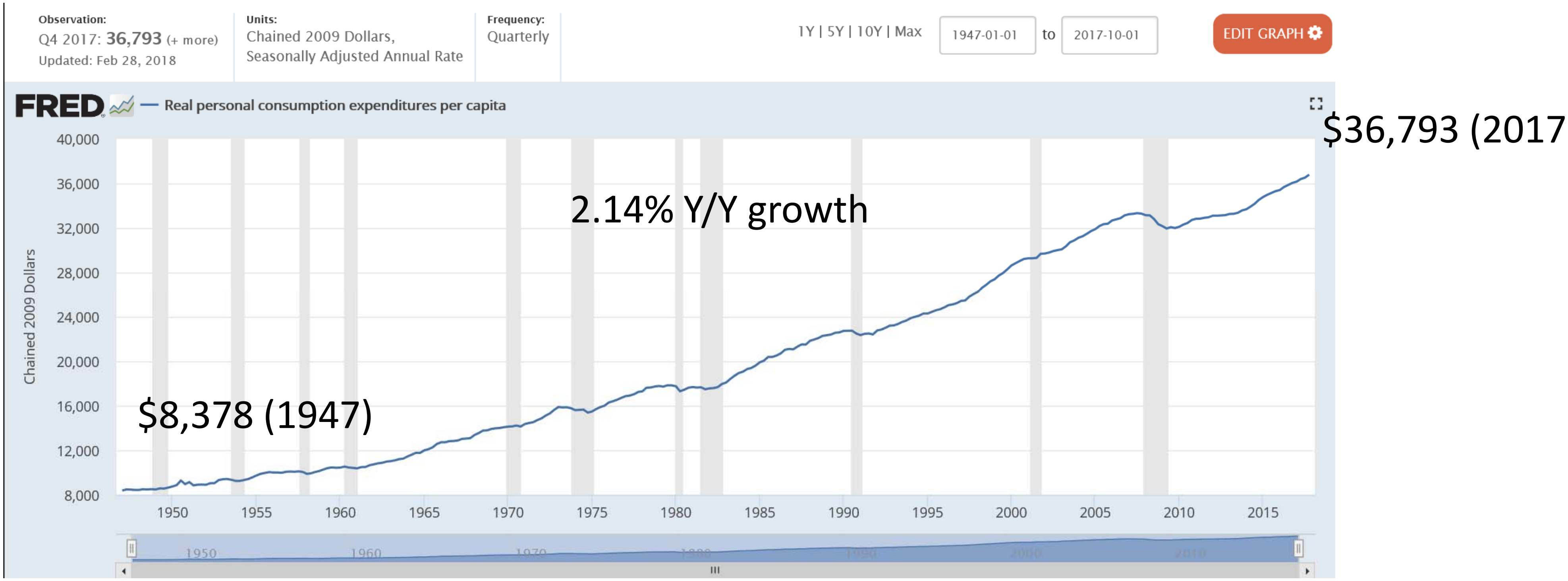
Economics of Intergenerational Impacts

- By discounting a future cost to zero, you are making a statement that the cost borne by future generations are irrelevant to the decision being made.
- The choice of an intergenerational discount rate may be considered a moral or ethical matter, not an economic decision
- Also, some projected growth rates have impossible economic considerations when considering intergenerational aspects
- Traditional methods may create “false future” to base decisions upon
  - Future generations may value habitat more significantly
  - Would we use the same approach and technology on today’s natural landscapes as we did in the past (e.g., straightened rivers, installed dams)?

The problem with using discount rates over generations

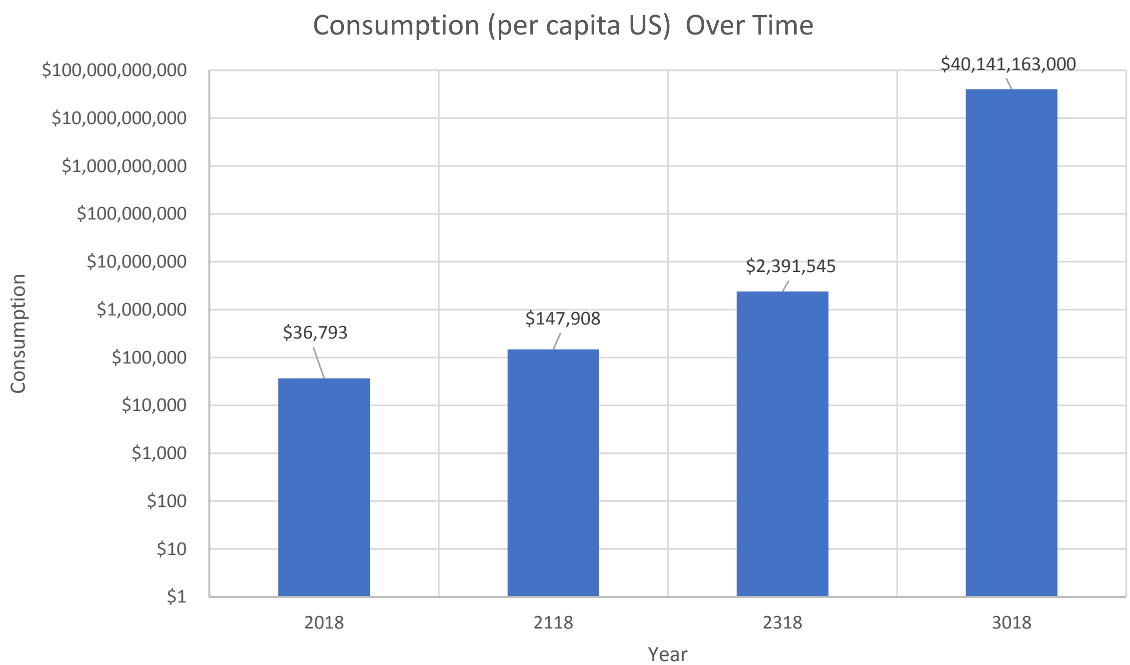
- The real interest rate should reflect cost and benefit to a single entity (e.g., a corporation) – not society
- Economy/values will change
- Technology will change and impacts on remediation costs are uncertain
- Not really intended to show values of future generations
- Future generations may have different values
- Would our great grand-parents have envisioned space travel and the internet?

Growth in Consumption (estimates vary)
1800-1984 (1.4%)[1]
1890-1984 (1.8%)[1]



1. From A. Rabl. *Ecological Economics*, Vol.17, p.137-145 (1996)

Can we sustain year over year growth for hundreds of years?



Assess how much we have changed in 200 years as a society

Is this kind of demand on resources sustainable?

What effect will population growth, societal improvement, technological development and climate change or "*extreme weather*" have on availability of resources

Many researchers recommend a declining discount rate over time (though there is disagreement on the rate and value of the decline)

Several countries, such as France and the UK, use this method for public projects

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Case study involving long-term cleanup at SSFL

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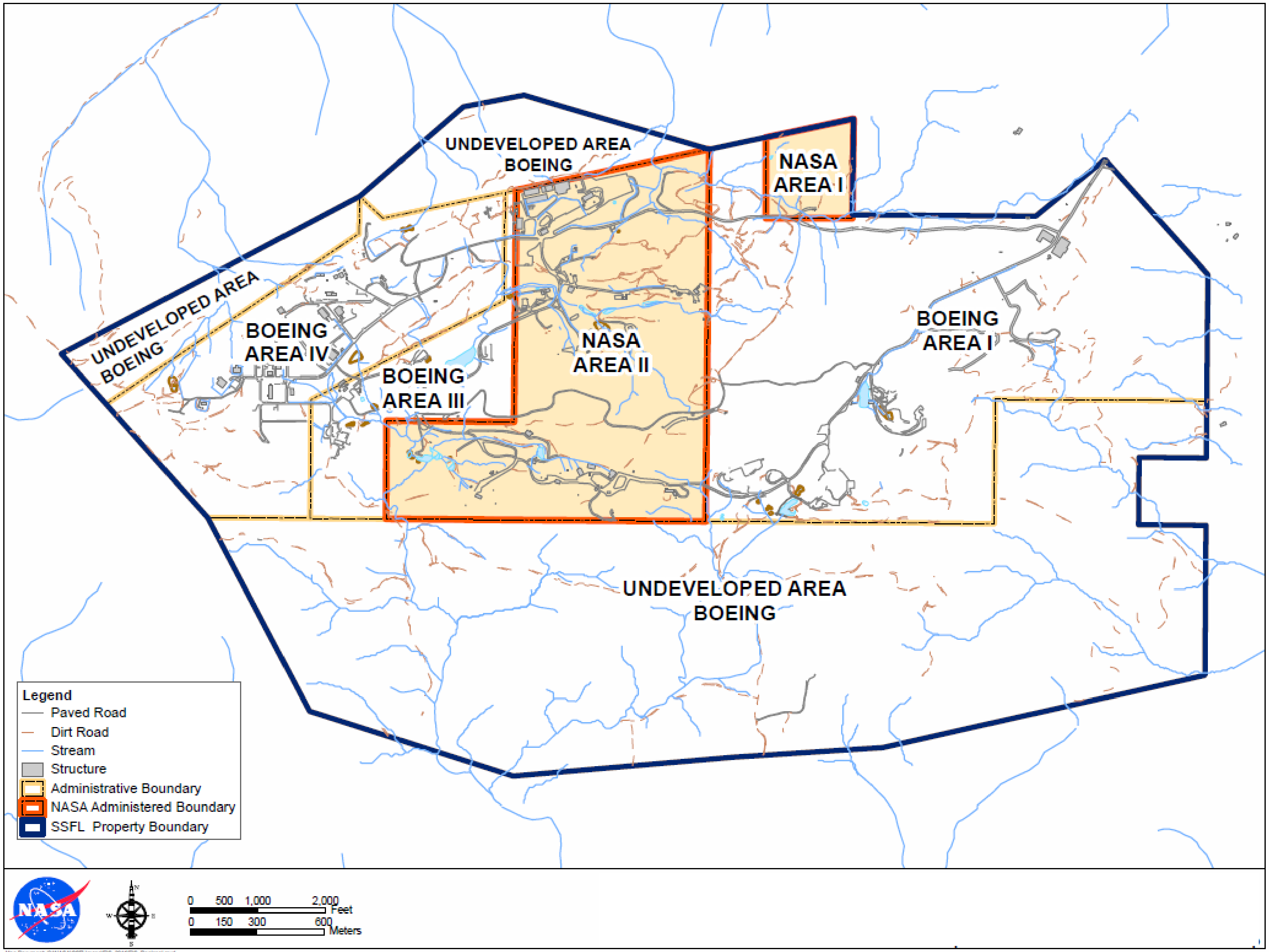

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AREA I
UNDEVELOPED AREA
BOEING
Legend
Paved Road
Dirt Road
Stream
Structure
Administrative Boundary
NASA Administered Boundary
SSFL Property Boundary
0 500 1,000 2,000
Feet
0 150 300 600
Meters

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Challenging Terrain

Photo of NASA Test Stand at SSFL (photo courtesy of NASA)

SSFL's Complex Terrain (photo courtesy of P. Favara)

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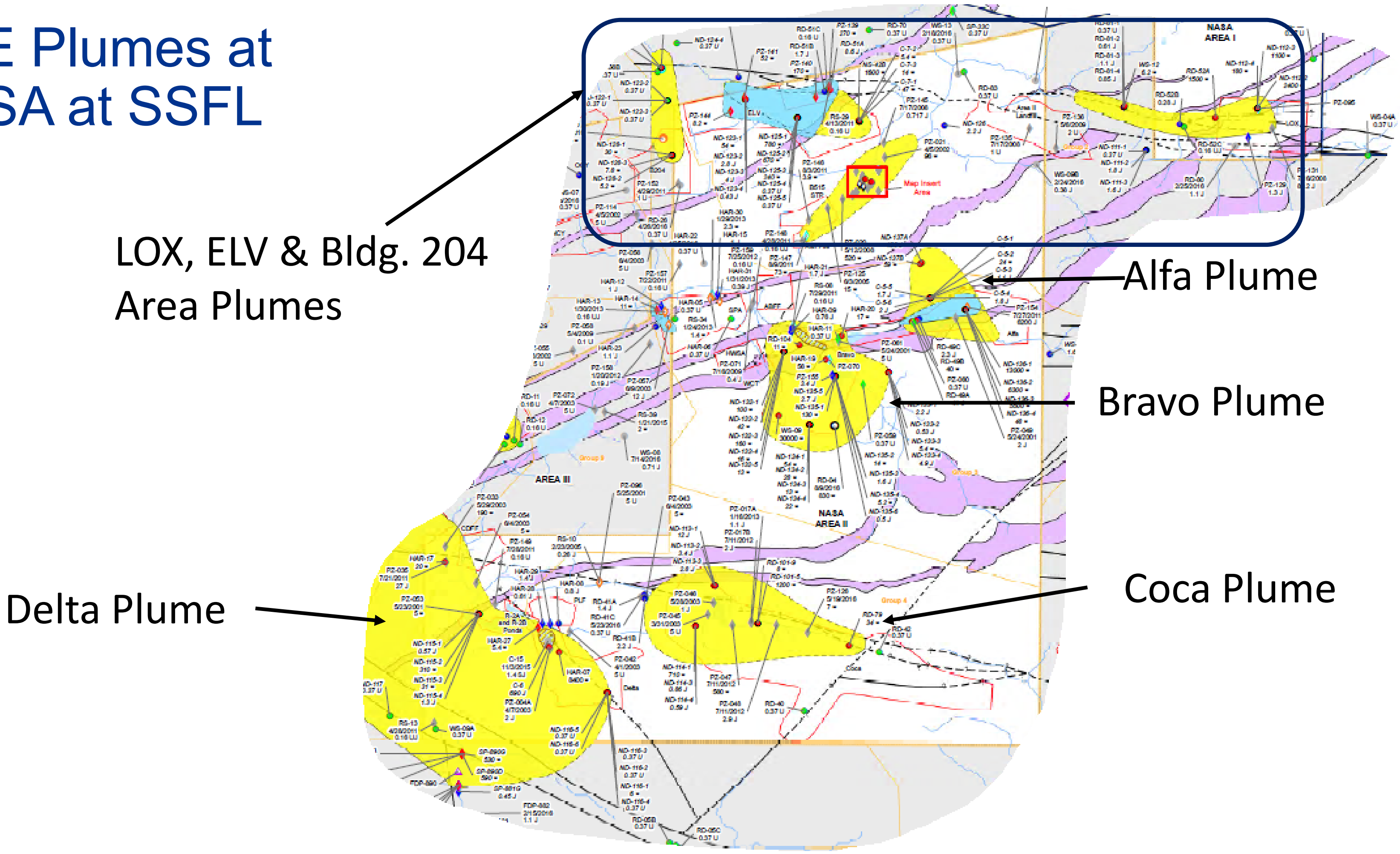
TCE Plumes at NASA at SSFL



From: SSFL NASA Area 1 LOX and Area II Groundwater Monitoring Report Annual 2017 (NASA, 2018)

How long should the groundwater CMS represent time to achieve cleanup objectives

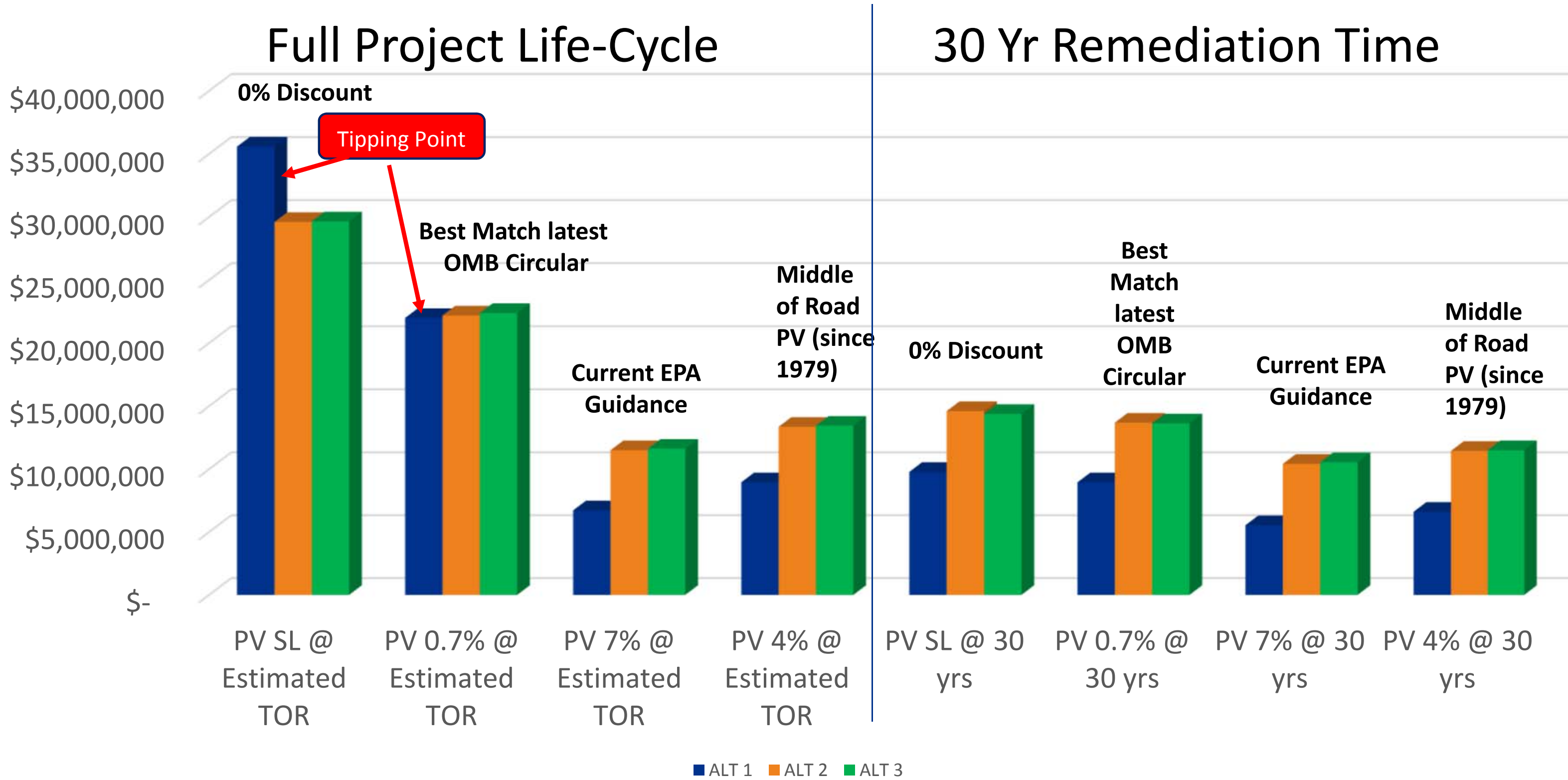
- Time of remediation for three alternatives considered for four different areas
- Plumes are stable (are not advancing)
- No continuing source adding to contaminants in the subsurface
- Time of Remediation varies from 35 to 380 years (alternative and area specific); timeframe driven by:
  - 60 year old plumes in a complex fractured sedimentary rock setting
  - Most of the contaminant mass is adsorbed in the rock matrix
    - Time of remediation is back diffusion limited
  - High TCE concentrations at three locations

Preliminary Time of Remediation Estimate for Different Alternatives

Alt 1 = MNA with land-use controls
Alt 2 = MNA with source area treatment via pump and treat
Alt 3 = MNA with source area treatment via EISB

Location	Only Natural Attenuation (years)	Natural Attenuation with Treatment of Target Treatment Areas on Figures 4-5 and 4-6 (years)	Reduction in Time to Achieve Media Cleanup Objectives
Alfa	185	140 (Alternative 3) and 150 (Alternative 2)	24% (Alternative 3), 19% (Alternative 2)
Bravo	380	290 (Alternative 3) and 300 (Alternative 2)	24% (Alternative 3), 21% (Alternative 2)
Delta	210	170 (Alternative 3) and 180 (Alternative 2)	19% (Alternative 3), 14% (Alternative 2)
LOX Areas 1, 2, 3, and 4	35(1) 105 (2)	Not Applicable	Not Applicable

Alternative Costs with Different PV and Time Scenarios (and the “tipping-point”)



Alt 1 = MNA with land-use controls
Alt 2 = MNA with source area treatment via pump and treat
Alt 3 = MNA with source area treatment via EISB

Interpretation of Cost with Different PV and Time Scenarios

- There is one important “tipping-point” with Alternative 1 for the zero discounting
- Alternatives 2 and 3 have inconsequential tipping points (virtually the same number)
- An approximately $5 million active remedy reduces time of remediation by 14- to 25-percent
  - is this significant given uncertainty in modeling and long-term projections?
  - Does it make sense to wait several years on more robust modeling results?
- Substantially larger target treatment area has a *de minimus* effect on the time of remediation
- Traditional 30 year estimates and 7% discount rate provide significantly different perspectives on life-cycle costs, compared to estimated time of remediation and lower discount rates

Selection of remedial alternative is complex and cost is only on factor to consider

The decisions required are complex and driven by multiple, often competing considerations

Monetization of value and risk

Current costs versus future costs

Current approaches to resource valuation vs future approaches

Impacts to ecosystem and habitat form and function

Stakeholder values (e.g., Native Americans)

Archeological and biologically sensitive areas

Freshwater Marsh – Open Water Habitat

(Photo courtesy of NASA)

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Adaptive Site Management

- One way to deal with uncertainty over long time frames
  - Likelihood of technical innovation is very high
  - Definition of what may be considered "done" in the future may change
  - Respond to unplanned events or observations
- Adaptive site management will be implemented to address long-term uncertainties in performance and awareness of new technologies
  - Plan for progress milestones and make changes if getting off track
  - Have a "Plan B" to implement, with different trigger points identified
- Drive periodic reviews to identify newer cost saving approaches
  - In-well sensing technologies or Star Trek field analyzers?
  - Remote Environmental Sampling Platforms (RESP™) using UAVs to reduce/eliminate road maintenance

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With a long-term cleanup, considerations on technology advancements

- Can we predict remediation technology in 30 years, and longer?
- Consider where we were we in 1988 and consider advancements since then?
- Can we bet on remote sensors and analyzers?
- Road maintenance is a significant cost - will our UAV Sampling Platform be ready soon?
- The need for adaptive site management and flexible decision documents is critical
  - Need to have milestones and objective standards that trigger periodic reassessment of technology and performance
  - Have “Plan B” ready to go

Conclusions and Recommendations

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Conclusions and Recommendations

- There is significant uncertainty in projecting long-term discount rates
- Environmental, social, and economic drivers across the globe have the potential to disrupt growth and stress resources
- There is no consensus on the correct intergenerational discount rate
- Using the USEPA recommended rate of 7% and limited to 30 years creates a false future on the true costs of long-term remedies and may result in misinformed decisions
  - E.g., makes passive long-term remedies look more cost effective that more active approaches
- Regulatory constraints can be more challenging in the future, with decreased detection limits and identification of more emerging contaminants

Conclusions and Recommendations

- Using lower interest rate seems appropriate for long-term cost estimates and is a hedge on uncertainty consumption in the future
- Incorporate adaptive site management and define transition points
- At a minimum, evaluate alternate discount rates, multiple discount rates, and different time horizons
  - The analysis may show no “tipping-points”
  - A tipping-point may require further evaluation to assure its impact on decision making is considered
- Consider use of declining discount rates over time
- Plan on the future with hovercraft access

Remote Environmental Sampling Platform (RESP) ™

Thank you!

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