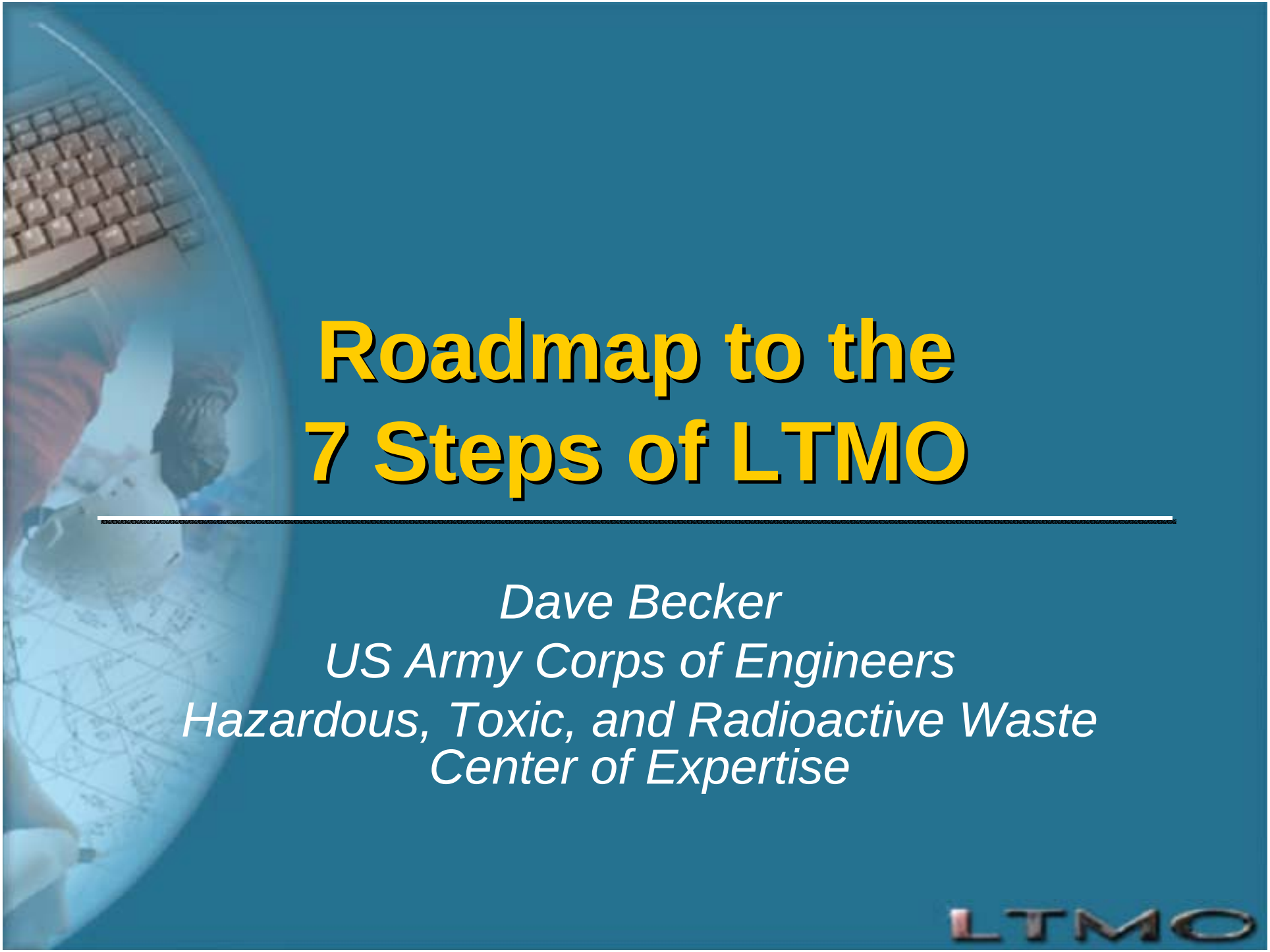


Roadmap to the 7 Steps of LTMO

Dave Becker
US Army Corps of Engineers
Hazardous, Toxic, and Radioactive Waste Center of Expertise

LTMO

Credits

This presentation was largely prepared by Mindy Vanderford, PhD Groundwater Services, Inc.

Roadmap for Long-Term Monitoring Optimization

Contributors:

Carolyn Nobel, PARSONS

John Anthony, Mitretek

Dave Becker, USACE

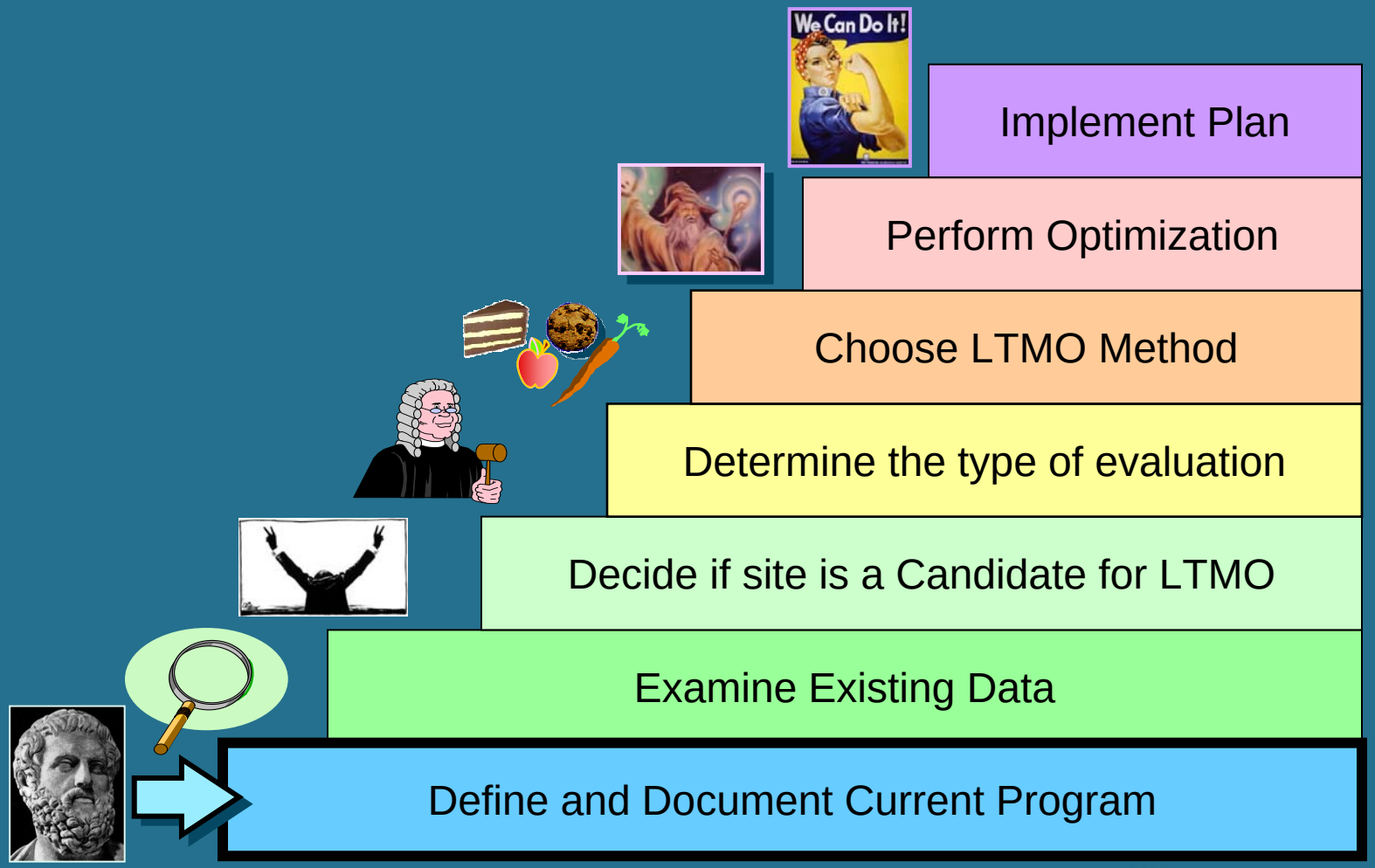
Demonstration of Two Long-Term Monitoring Optimization Methods

USEPA Office of Superfund Remediation and Technology Innovation

Goals

- *Introduce language,concepts and methods central to LTMO*
- *Define steps common to LTMO analyses*
- *Determine if and when optimization is appropriate for your program*

7 Steps of LTMO

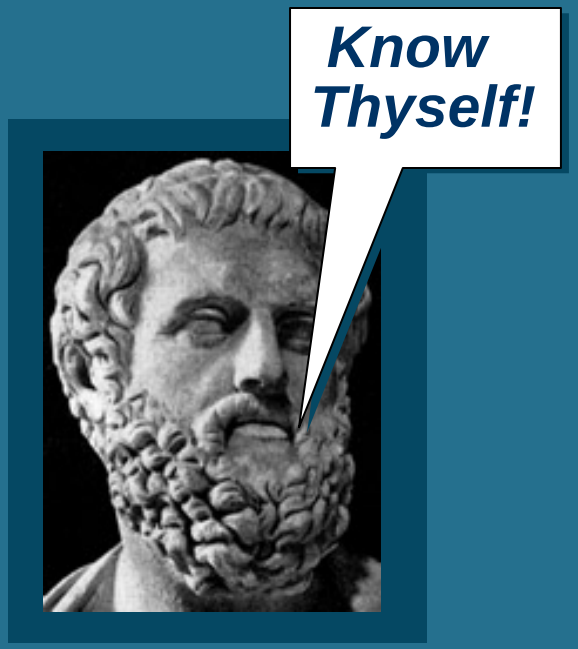


LTMO

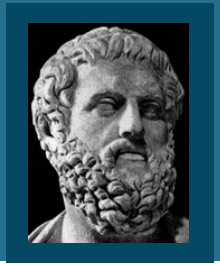
Current Monitoring Program

Components of your Current Monitoring Program

- Conceptual Site Model
- Objectives
- Design of Monitoring Program
- Management Decision Rules

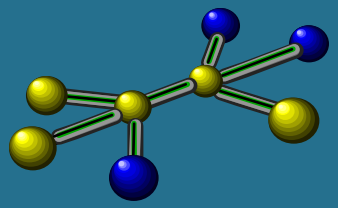


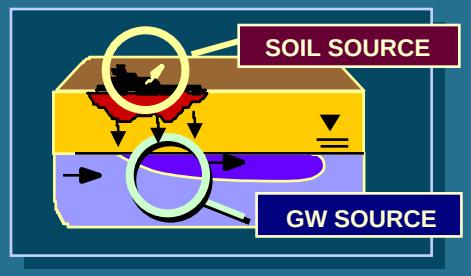
Current Monitoring Program

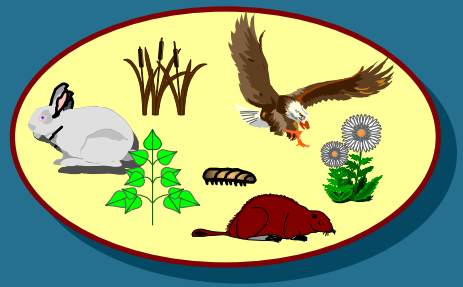


Conceptual Site Model

- Sources
- Analytes
- Matrices
- Potential receptors
- Regulatory framework
- Property use/community issues
- Assumptions/Uncertainties

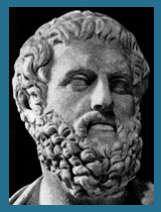






LTMO

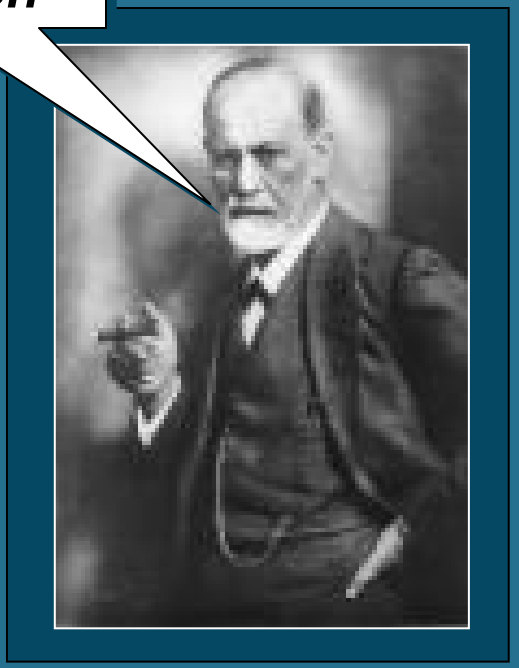
Current Monitoring Program



Objectives

- Monitoring Objectives
  - Evaluate remedy effectiveness
  - Evaluate contaminant migration
  - Evaluate changes in natural resource
  - Comply with regulatory requirements

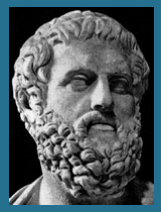
Understand your motivation



(USEPA, 2004)

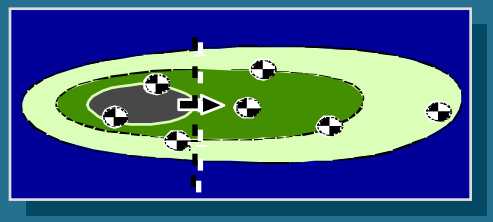
LTMO

Current Monitoring Program



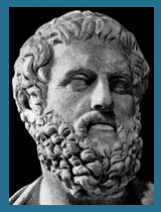
Design of Current Monitoring Program

- What data have been collected and why?
  - Analytical methods
  - Detection limits
- How are data collected?
- Where have data been collected?
- How have data been analyzed?
- How is the dataset managed?
- How much does this cost?
- Who is paying for this?



LTMO

Current Monitoring Program



Management Decision Rules

- Identify actions taken and criteria for actions taken.
- Have monitoring objectives been met?
- How has the monitoring program been altered through time and why.

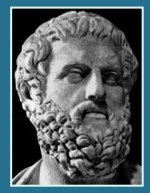
LTMO

Current Monitoring Program

Regulatory/Community Issues

- Is the site moving to a different regulatory status/phase?
- What are the long-term goals of property re-use?
- What is my current relationship with stakeholders?
- How can LTMO improve the current stakeholder relationship/property re-use?

7 Steps of LTMO



Define and Document Current Program

Examine Existing Data

Decide if site is a Candidate for LTMO

Determine the type of evaluation

Choose LTMO Method

Perform Optimization

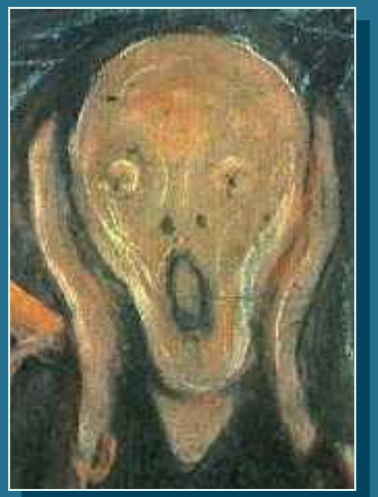
Implement Plan

LTMO

Examine Existing Data

Acquire and Process Data

- Data acquisition and availability
- Data format
- Data reduction

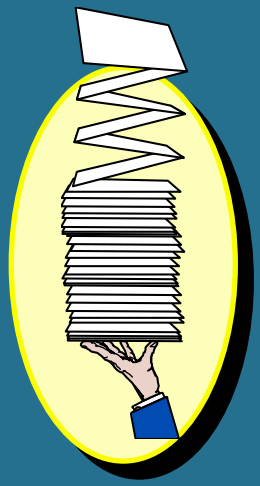


LTMO

Examine Existing Data

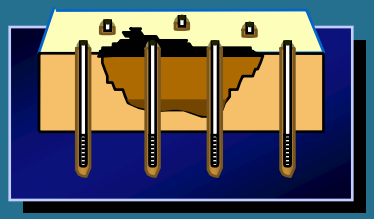
Checklist *(Important stuff)*

- Site description/history
  - RFI, CSM, ROD
- Historical COC data
  - Investigation and monitoring reports
- Site hydrology/geology
  - RFI, CSM
- Cleanup Actions
  - May affect comparability of data
  - Nature of past actions and timing of actions
  - Before and after comparison

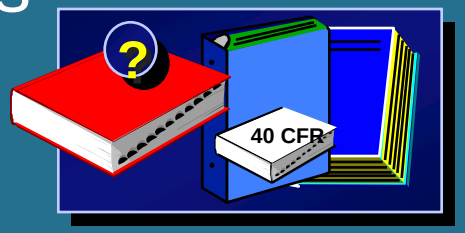


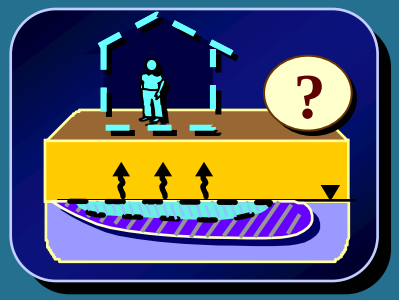
Examine Existing Data

Checklist *(Important stuff)*



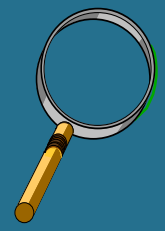
- Well construction/completion intervals
  - Construction diagrams
- Coordinates of the Sampling Points
- Regulatory context, cleanup goals
  - Risk based goals
- Location of potential receptors
  - Risk assessments





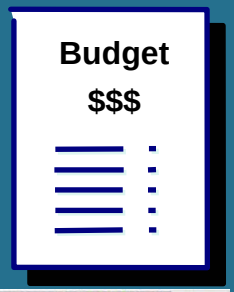
LTMO

Examine Existing Data



Checklist *(Useful stuff)*

- Logistical and policy issues
  - – Stakeholders, property owners
- Site features
  - – Aerials, AutoCad, GIS base maps
- Historic hydrology
- Geochemistry
- Costs and budgets



LTMO

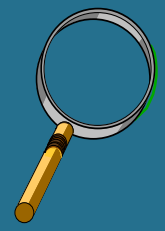
Examine Existing Data

Data Format

Clean-up your data!

- Hunt, gather, beg, create
- Convert to electronic files
- Database format
- Identify spurious points/artifacts
- Data deficiencies?

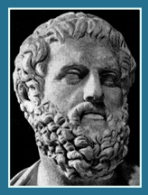
Examine Existing Data



Data Reduction

- Data Comparability
  - How are data flags handled?
  - Non-detect results
  - Dilution factors
  - Changes in Sampling Methods/Crew
  - Unusual Climatic Effects
- How are duplicates interpreted?
- Data consolidation

7 Steps of LTMO



Implement Plan

Perform Optimization

Choose LTMO Method

Determine the type of evaluation

Decide if site is a Candidate for LTMO

Examine Existing Data

Define and Document Current Program

LTMO

Candidates for LTMO

Is my site a Candidate?

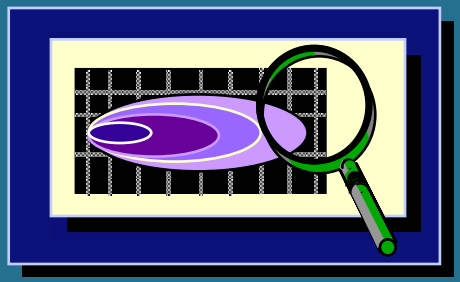
- Is the site investigation complete?
- Minimum Data requirements fulfilled?
- Remediation status consensus?
- Budget and labor considerations?

LTMO

Candidates for LTMO

Is my site a Candidate?

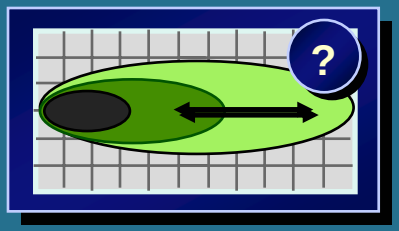
- *Is the site investigation complete and Conceptual Site Model complete?*
  - Source identified?
  - Plume delineated (vertically and horizontally)?
  - COC's identified?
  - Hydrology known/modeling complete?

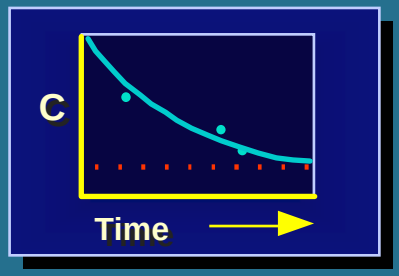


Candidates for LTMO

Is my site a Candidate?

- *Data requirements fulfilled?* ✓
  - Temporal: > 4 to 6 sample events, 8 events suggested for significance for some statistical tests



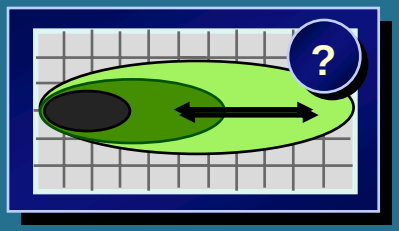


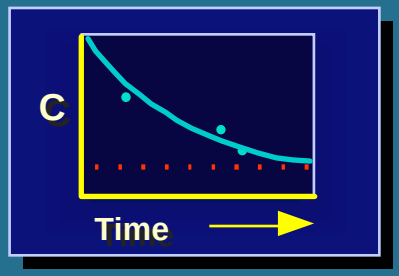
LTMO

Candidates for LTMO

Is my site a Candidate?

- *Data requirements fulfilled?* ✓
  - Spatial: > 6 to 15 monitoring locations
  - Spatial: Coverage adequate vertically and horizontally
    - Multiple aquifers
  - Housekeeping: data organized and complete



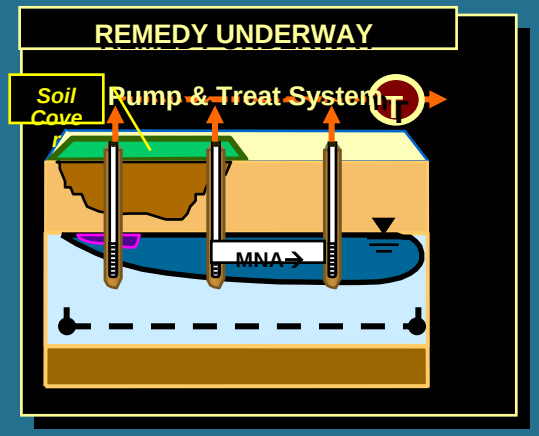


LTMO

Candidates for LTMO

Is my site a Candidate?

- *Remediation status confirmed?*
  - Stakeholders agree
  - Intensive remedies completed
    - No major pending changes
  - Pump and Treat or Natural Attenuation remedies on-going



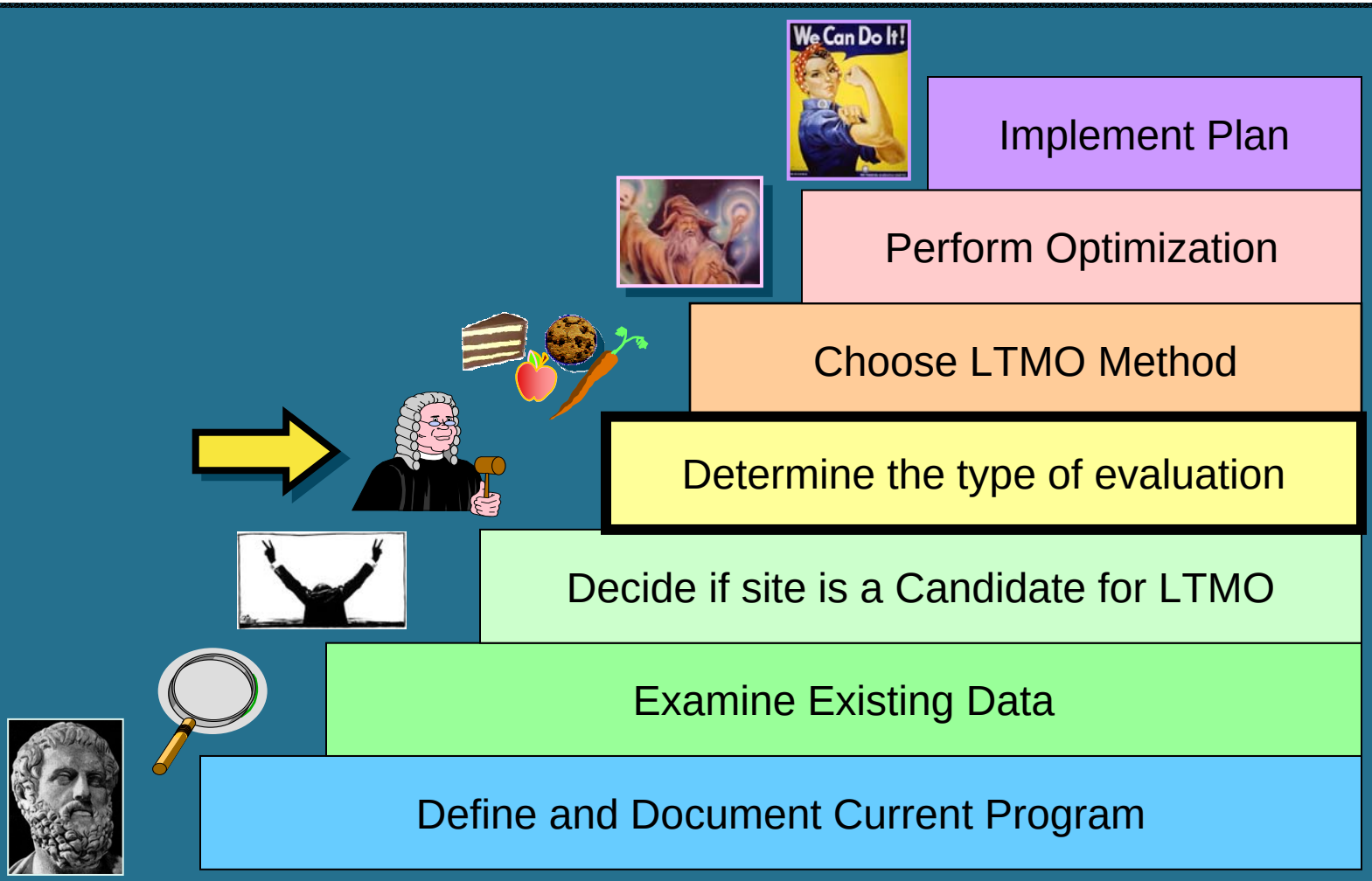
LTMO

Candidates for LTMO

Things to consider

- Effort and budget to perform optimization
- Technical capabilities of team
- Resistance to implementation
- Potential benefits vs. cost
- Deficiencies in current monitoring program
- Likelihood of further remediation

7 Steps of LTMO

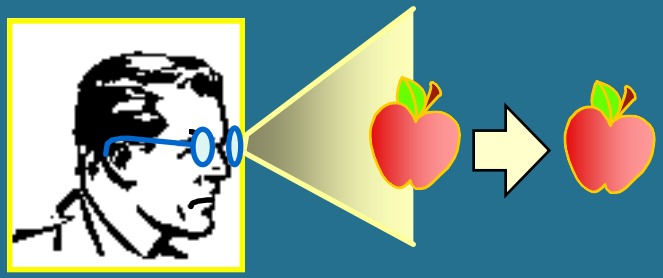


LTMO

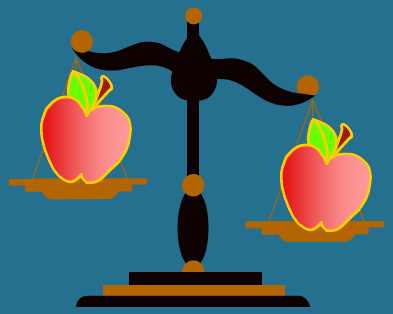
Evaluation Type

Evaluation Strategies

Qualitative



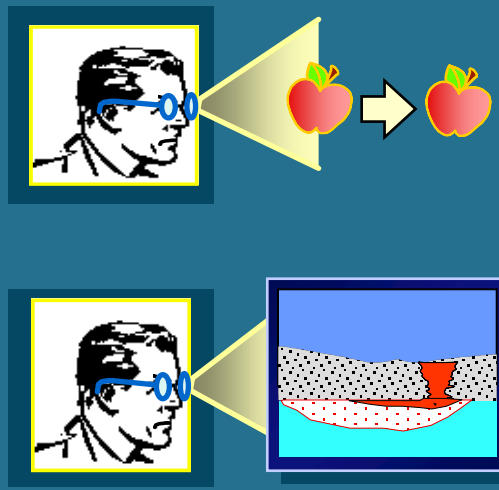
Quantitative



Evaluation Type

Evaluation Strategies

Qualitative evaluations based on professional judgment, intimate knowledge of site, decision rules, heuristic methods

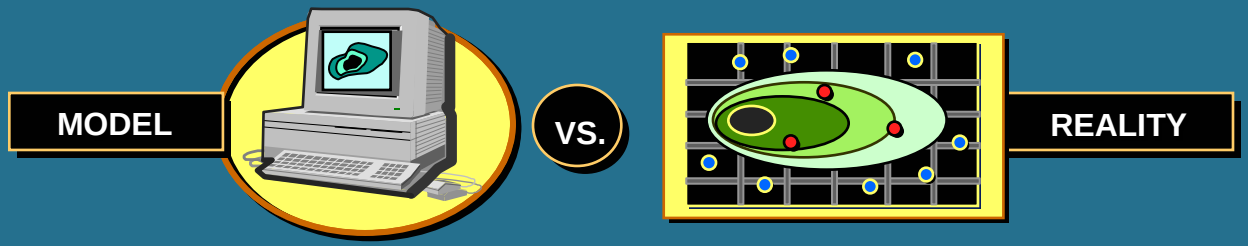


Evaluation Type

Good News

Qualitative Evaluations

- Context specific, multiple factors, includes intuitive, less tangible information
- Good for including regulatory and community issues



LTMO

Evaluation Type

Less-Good News

Qualitative Evaluations

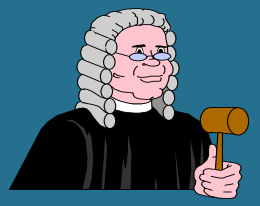
- Problem if stakeholders do not agree
- Consultant dependent
- May not reveal data inadequacies, may carry over biases
- Specific personnel required

Evaluation Type

Evaluation Strategies

Quantitative evaluations based on statistical, mathematical, modeling or empirical evidence

Evaluation Type



Good News

Quantitative Evaluations

- Bring stakeholders together with quantitative analysis
- Specific justification for action
- Can highlight data deficiencies, mis-interpretations, uncertainty.

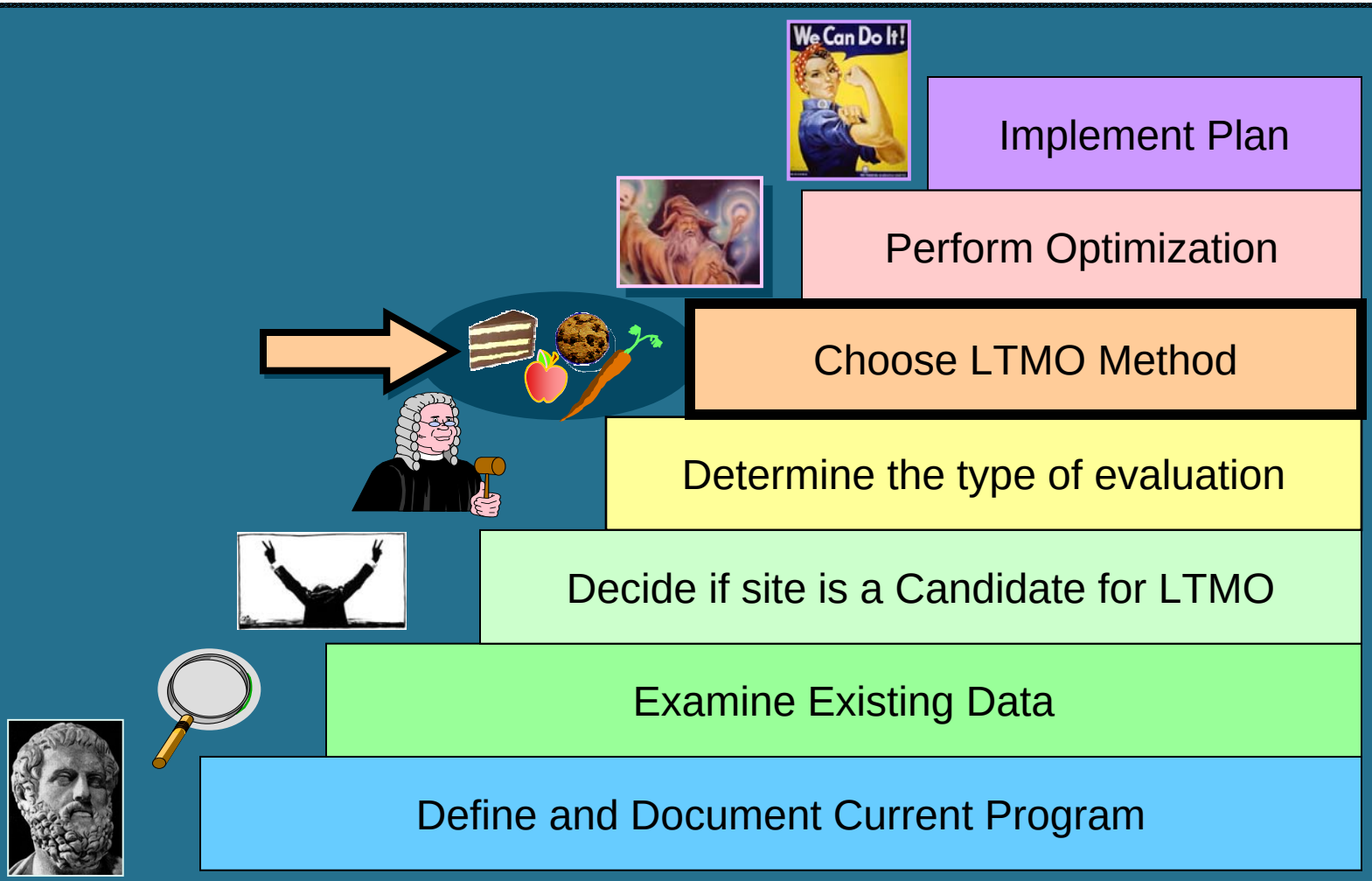
Evaluation Type

Less-Good News

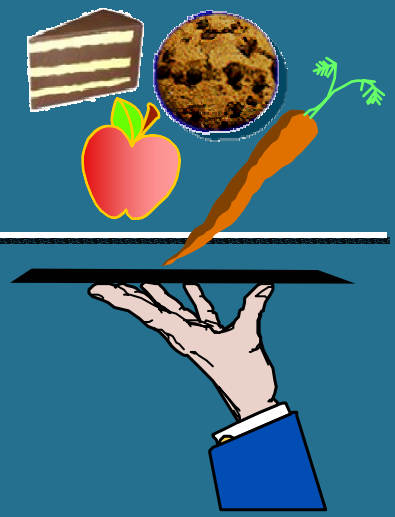
Quantitative Evaluations

- More rigorous data requirements
- Cost
- Time and effort
- Technical expertise
- Junk in → Junk out

7 Steps of LTMO



Choose LTMO Method



LTMO Methods

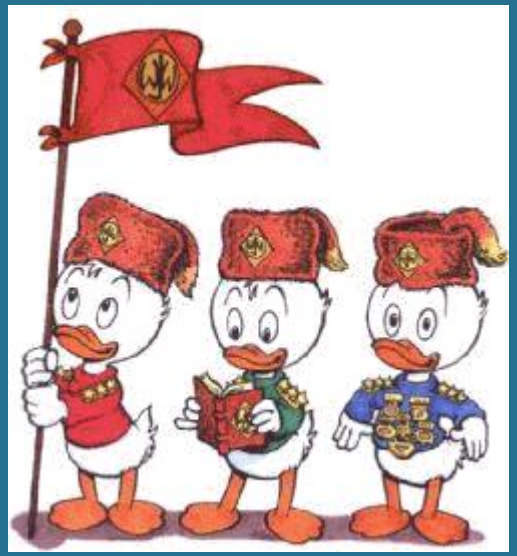
Choice should reflect:

- Balance qualitative and quantitative methods
- Time, effort, skill set and cost
- Stakeholder consensus
- Appropriate to size, complexity, dataset and risk of site

Choose LTMO Method

LTMO Team

- Geology/hydrology
- Statistical
- Data management
- Regulatory
- Chemistry

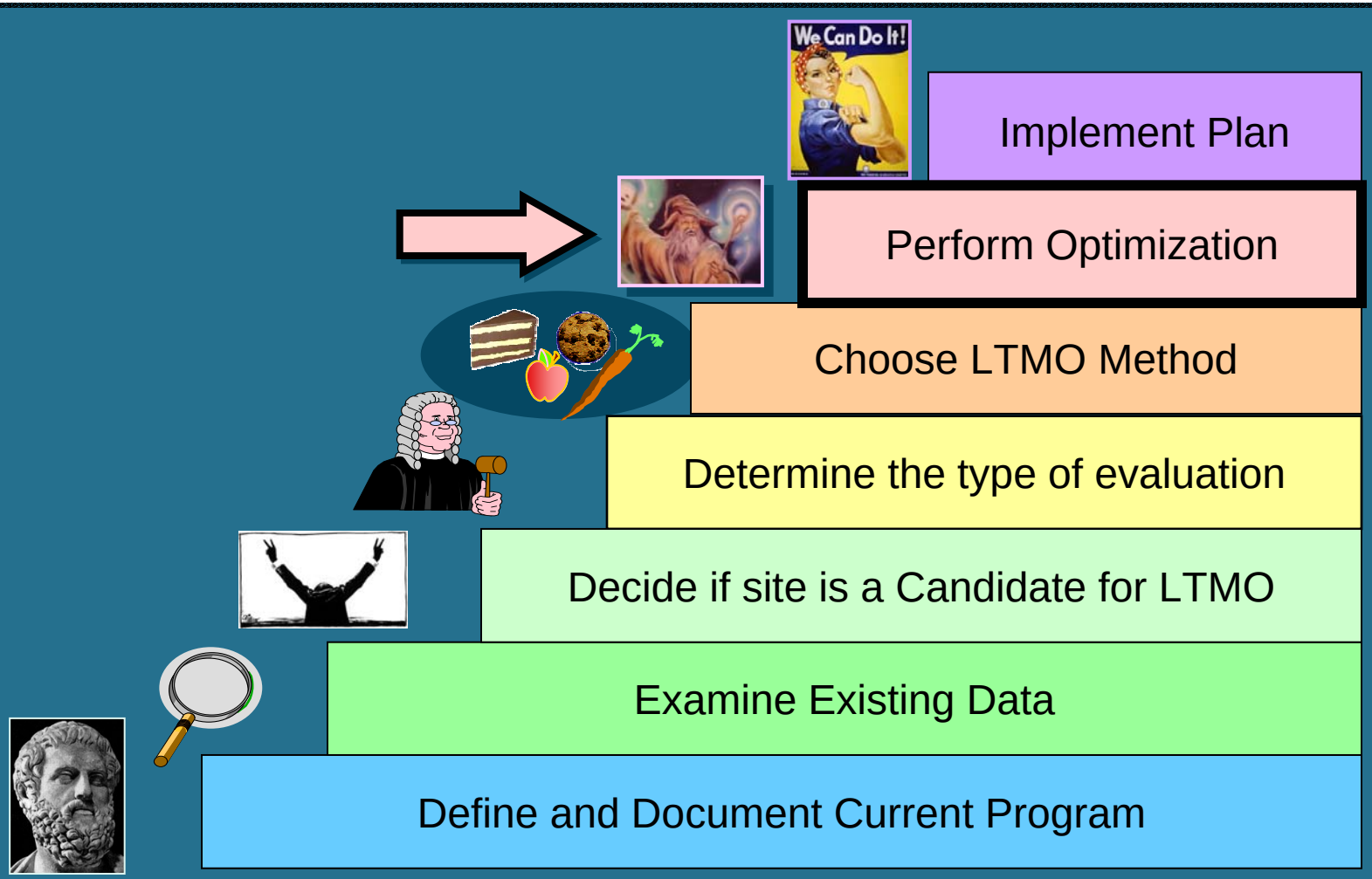


Choose LTMO Method

LTMO Methods

- Cost Effective Sampling
- Parsons Three Tiered
- MAROS (Monitoring and Remediation Optimization Software)
- GTS (Geostatistical Temporal/Spatial Optimization Algorithm)
- Mathematical Optimization Methods

7 Steps of LTMO



Perform Optimization

Expected Results

- Spatial – Locations
  - Remove wells from program
  - Addition of wells to characterize high uncertainty
- Temporal – Frequency
- Different results for different COCs
- Different results for different GW units

LTMO

Perform Optimization

Bonus Results

- Change in site conceptual model
- Change in monitoring objectives
- Change in sampling or analytical methods
- Evaluate effects of remediation activities

LTMO

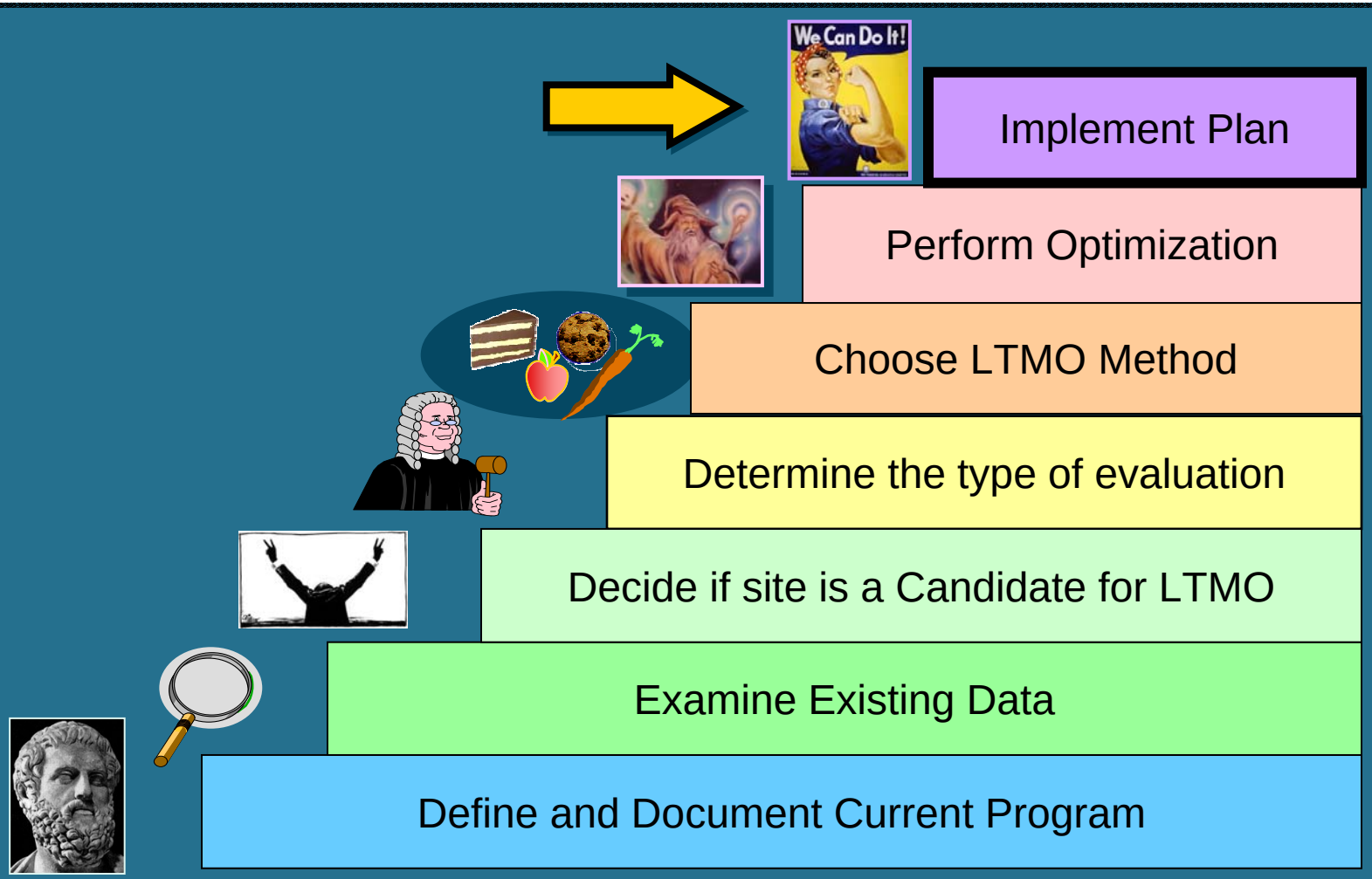
Perform Optimization

Cost

- Small site, stakeholder agreement, uncomplicated hydrology and constituents
  - $2,500 - $5,000
- Larger site, stakeholder skepticism, uncomplicated hydrology
  - $5,000 - $15,000
- Larger site, stakeholder hostility, complicated hydrology, multiple units, legal issues
  - >$25,000

LTMO

7 Steps of LTMO



LTMO

Assess and Implement

Assessment and Implementation

- Quantitative results must be reviewed qualitatively by project technical staff
  - Consider site hydrogeology
  - Consider recent and future changes
    - Production and land use
    - Impacts of climate, other factors
  - Qualitative review may “trump” quantitative
  - Cost savings review

LTMO

Assess and Implement

Assessment and Implementation

- Implementing LTMO recommendations correctly
  - Future data collected so as to verify recommendations and/or adjust at 3-5 yr review
- Temporal considerations
  - If sampling frequency is lowered, stagger reduced sampling schedule among groups of wells to allow:
    - Continued capture of seasonal fluctuations
    - Inter-event times of sufficient variety to enable estimates of temporal correlations between sampling events

Assess and Implement

Assessment and Implementation

- Spatial considerations
  - Redundant wells perhaps should not be abandoned
    - Sample at multi-year reviews to test whether the optimized locations are correctly estimating values at unsampled spots
    - Provides a natural and convenient source of ‘verification’ data – measurements used to ‘verify’ the LTMO predictions
    - Water level data

Assess and Implement

Other Considerations

- May need to adjust LTMO recommendations
  - Follow-up optimization efforts
  - Independent review of original LTMO
- Stakeholder review
- Vendor contracts/services

Assess and Implement

Other Considerations

- *Flexible decision documents*
- *Periodic re-evaluation*
  - *Acquisition of statistically significant sample size*
  - *Change in well status (i.e. <MCL)*
- *Property transactions*

LTMO

Assess and Implement

Costs

- *Modification of documents*
- *Modify permits, and institutional controls*
- *Potential savings ~ $750 per sample*
  - *Labor*
  - *Analytical*
  - *Data Management*

LTMO

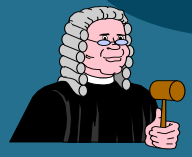
7 Steps of LTMO

Review

Implement Plan

Perform Optimization

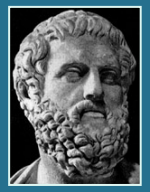
Choose LTMO Method



Determine the type of evaluation

Decide if site is a Candidate for LTMO

Examine Existing Data



Define and Document Current Program

LTMO