Water Train

A better way to transport water

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Saving California

Outlook 2015
- Snowpack – 6% of normal
- Reservoir – 40-70% of normal levels
- Groundwater – 200-300% above recharge rate
- Colorado River – 20% reduced flow

Outlook 2050
- 50% decrease in annual water supply possible

Outlook 2100
- 75% decrease in annual water supply possible

California faces an existential threat!
Responses:
1. Conservation
2. Redistribution
3. Desalination
4. Importation

Only options to keep pie from shrinking and provide baseline water security.
The problem with pipelines

**Expensive** - Pumping uphill requires huge pump infrastructure. Pipes are expensive.

**Inefficient** - Large frictional losses in pipe due to water drag.

**Slow** – Construction can take decades

**Vulnerable** - Long-term supply disruption after infrastructure attack
Introducing the Water Train

**Efficient:** Same operating power requirements as pipeline - ~2GW(e)

**Cheaper:** 1/2 the capital cost, lower operating costs

**Robust:** modular design allows rapid replacement of track and vehicles

**Greener:** Much smaller carbon footprint

**Investing in America:** Springboard to new US industries in Maglev Transport, Energy Storage, and Space Launch. This is an investment that pays for itself many times over.
Introducing the Water Train

Vehicle Structure with Superconducting magnets

Precast beam or concrete filled form with foam core
Mississippi River Water Train

- 2 Billion gallons per day to Lake Mead (0.5% of Miss. River)
- $59B construction cost
- 1,500 miles
- $3.46 per 1000 gallons
  - amortized capital costs - $2.70
  - Operating costs - $0.76
- water for 20 million people
Compared to Traditional Pipeline...

<table>
<thead>
<tr>
<th></th>
<th>Pipeline</th>
<th>Water Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>$123B</td>
<td>$59B</td>
</tr>
<tr>
<td>Construction time</td>
<td>15 years</td>
<td>5 years</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>~2 GW</td>
<td>~2 GW</td>
</tr>
<tr>
<td>Operating Cost</td>
<td>$$</td>
<td>$</td>
</tr>
<tr>
<td>Time to recover from terror attack</td>
<td>Months</td>
<td>1 Week</td>
</tr>
<tr>
<td>Delivered Cost ($ per 1000 gallons)</td>
<td>$8.03</td>
<td>$0.00</td>
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</tbody>
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Pipeline
- Five 5 m diameter pipelines required
- Water flows at 1 meter per second

Water Train
- One 2-way guideway
- Trains travel at 150 mph

(delivered costs include freight and energy storage revenues)
Lasting economic benefits

**Water security** – Protecting state economies from permanent GDP and job loss

**New American industries** – Development of Water Train tech would accelerate maglev passenger and freight transportation and grid energy storage industries.

**Revitalized national infrastructure** – enabling US to compete against China and Europe
Bonus Energy Storage – enabling renewable energy

- 4000 foot descent from New Mexico Plateau to Lake Mead
- Maglev Power Storage (MAPS): >90% recovery of energy
- 2 GWh Storage Per Day
- Load shifting: run 10% of deliveries down 4000 ft descent between 2PM and 6PM
- Energy storage revenues can offset ~10% of amortized capital costs
Paying for Water Train with freight transport

- Increased trucking in Southwest
- System can carry 4,000+ trucks and containers per day
- **Pays 100% of capital and operating costs**
- <10% of projected regional truck freight volume
# Water Train RDT&E Plan

<table>
<thead>
<tr>
<th>Phase</th>
<th>Objectives</th>
<th>Duration</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Phase 1</td>
<td>Peer-reviewed feasibility study</td>
<td>6 months</td>
<td>$5 Million</td>
</tr>
<tr>
<td>Phase 2</td>
<td>Core Components Manufacture</td>
<td>2 years</td>
<td>$20 Million</td>
</tr>
<tr>
<td>Phase 3</td>
<td>20 km full-scale demonstration</td>
<td>2 years</td>
<td>$200 Million</td>
</tr>
</tbody>
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Supplemental Slides
<table>
<thead>
<tr>
<th>Pro Business</th>
<th>Shared Priorities</th>
<th>Pro Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Water security = business stability</td>
<td>• Water security = state economic viability</td>
<td>• Grid-scale renewable energy storage</td>
</tr>
<tr>
<td>• Self-funding and cash flow positive with freight</td>
<td>• Lower transportation and energy infrastructure costs</td>
<td>• <strong>Carbon negative</strong> when transporting trucks and powered by wind and solar</td>
</tr>
<tr>
<td>• Lower logistics costs for businesses</td>
<td>• American leadership in emerging maglev industry</td>
<td>• Can be tied to complete environmental water policy</td>
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<tr>
<td></td>
<td>• <strong>100s of thousands of new jobs</strong></td>
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Mississippi River Water Train... *Broader Vision*

- 2% of Mississippi River outflow
- Water security for TX, NM, AZ, NV, and CA
- $100B capital costs covered by freight transport
- Water for 80 million people
Columbia River Water Train

• 2 Billion gallons per day to Lake Shasta (1% of Columbia River)
• $20B construction cost
• 350 miles
• water for 20 million people
• probably politically unpopular in Washington and Oregon
MAGLEV QUADRUPOLE - MONORAIL

- Dr. James Powell and Gordon Danby 2\textsuperscript{ND} Generation Maglev 2000 Design

- Hollow prefabricated box beam elevated monorail guideway with polymer concrete panels with aluminum loops to provide vertical lift, lateral stability, and linear synchronous propulsion provides for safe highspeed operations.

- Superconducting quadrupole magnets can run even after the power supply has been shut off for example in the event of a blackout.

- It’s 4 inch operating clearance can operate in ice and snow conditions. The 4 inch gap allows ground movement such as caused by earthquakes.
MAGLEV QUADRUPOLE - PLANAR

- Quadrupole Magnets permit using existing railways and infrastructure with little modification
- Less expensive than elevated guideway
- Less disruptive when accessing built up metropolitan areas
- Maglev can switch from high speed guideways to planar mode without mechanical switches
- Compatible with Maglev 2000 passenger or freight design vehicles
- Planar disadvantage is lower speed with current crossroad hazards.

Passenger Vehicle
Freight Vehicle

ALUMINUM LOOPS IN POLYMER CONCRETE PANELS FOR PROPULSION, VERTICAL, AND LATERAL STABILITY