SPCC COMPLIANCE: DESIGN BUILD CONSIDERATIONS FOR SECONDARY CONTAINMENT

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OVERVIEW

- Overview of Secondary Containment
  - Focus: Bulk Storage Tanks > 100,000 gallons
  - Earthen Dikes
  - Concrete Dikes
  - Steel Wall Systems
- Pre-Design
- Design
- Construction
- Example Projects

Pre-Design Considerations

- Existing Dikes
  - Assess existing containment capacity
  - Assess whether dike is sufficiently impervious
  - Inspect dikes prior to design
- New Containment
  - Evaluate available land and space limitations
  - Locate and map utilities

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Pre-Design – Existing Dikes

- Assess existing containment capacity
  - Calculating existing containment capacity using field measurements typically not reliable
  - Horizontal dimensions can be measured accurately, but vertical dimensions are potentially very inaccurate
  - Vertical dike height is only as good as the lowest elevation point on the top of dike (i.e., spill-over elevation)
  - For a 500' x 500' earthen dike, one vertical inch represents approximately 156,000 gallons
  - Hire a licensed surveyor to survey dike, determine existing spill-over location and elevation, and perform volume calculations
  - Topographic land surveys with calculations performed by CADD software (e.g., AutoCAD® Civil 3D®) significantly more accurate than field measurements and hand calculations

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Pre-Design

Comparison of Surveys Vs. Field Measurements

Site/Containment Area(s)	Hand-Measured Containment Volumes (gallons)	Survey Calculated Volumes (bbl)	Volume Difference (gal)	Percent Difference
SITE A				
Area 1 (Tank 864)	1,837,916	1,335,004	502,913	**27.36%**
Area 2 (Tank 866)	2,431,630	965,572	1,466,059	**60.29%**
Area 3 (Tanks 875, 114, and 655-50)	1,777,045	1,366,399	410,646	**23.11%**
Area 4 (Tank 880)	3,058,526	1,381,729	1,676,798	**54.82%**
Area 5 (Tank 865)	2,352,821	1,439,390	913,431	**38.82%**
Area 6 (Tank 867)	1,869,771	1,178,797	690,974	**36.95%**
Area 7 (Tank 876)	3,584,204	2,631,518	952,686	**26.58%**
Area 8 (Tank 877)	4,372,556	2,663,287	1,709,269	**39.09%**
Area 9 (Tank 878)	3,875,724	3,045,995	829,729	**21.41%**
Area 10 (Tank 879)	3,908,103	2,422,384	1,485,719	**38.02%**
SITE B				
Area 1 (Tanks 225, 345, 797, 1427, 6018, and 6019)	1,400,952	1,389,478	11,474	**0.82%**
SITE C				
Area 1 (Tank 855)	2,143,569	1,664,151	479,417	**22.37%**
Area 2 (Tank 856)	1,964,809	1,738,779	226,030	**11.50%**
Area 3 (Tanks 857)	2,886,680	1,913,470	973,211	**33.71%**
Area 5 (Tank 859 and 115)	2,511,724	1,926,128	585,596	**23.31%**
Area 6 (Tank 860)	1,993,817	1,531,261	462,556	**23.20%**
SITE D				
Area 1 (Tank 1446)	1,398,166	1,271,248	126,919	**9.08%**
Area 2 (Tank 1448)	1,415,407	1,319,191	96,217	**6.80%**
Area 3 (Tanks 1450)	1,394,276	1,011,457	382,819	**27.46%**
SITE E				
Area 1 (Tanks 533 and 535)	386,235	342,636	43,599	**11.29%**
SITE F				
Area 1 (Tanks 1510 and 1511)	1,862,868	1,308,901	553,967	**29.74%**

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Pre-Design – Existing Dikes

- Inspect dikes prior to design
  - Earthen dikes: Look for signs of erosion, subsidence, animal activity (burrows, etc.) and whether dike is sufficiently impervious
  - Check for signs of distressed or sparse vegetation, or rooted plants

Animal burrowing can affect both the containment capacity and the structural integrity of the dike

Rock covered dikes can help minimize animal burrowing

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Pre-Design – Existing Dikes

- Inspect dikes prior to design
  - Concrete dikes: Inspect for cracks
  - Pipe penetrations through dike walls should be sealed

Design Considerations

- NFPA 30 Requirements
- OSHA considerations
- Displacement volumes of smaller tanks
- Dike construction materials
- Space limitations & utilities
- Facility operations
- Pre-construction volume calculation
- Other considerations

National Fire Protection Association (NFPA) 30

- Tanks need to be accessible for firefighting purposes
  - Slope > 1% away for at least 50 ft. or to dike base
  - Outside base of dike must be at least 10 ft. away from property line
  - Dikes > 3 ft. in height shall have minimum 2-ft. wide crest, and slope of dike shall be consistent with angle of repose
  - Dikes containing 2 or more tanks should be divided by drainage channels or intermediate dikes to prevent spills from endangering adjacent tanks.

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NFPA 30

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Occupational Safety and Health Administration (OSHA) Considerations

- Confined Space Considerations
  - Does the containment have limited or restricted means of entry or exit?
  - Is the containment designed or configured for continuous occupancy?
  - Is the containment deeper than 4 feet?
- Area surrounding tank(s) shall be provided drainage or be diked
- Volumetric capacity (minus displacement volumes) must be greater than largest tank.

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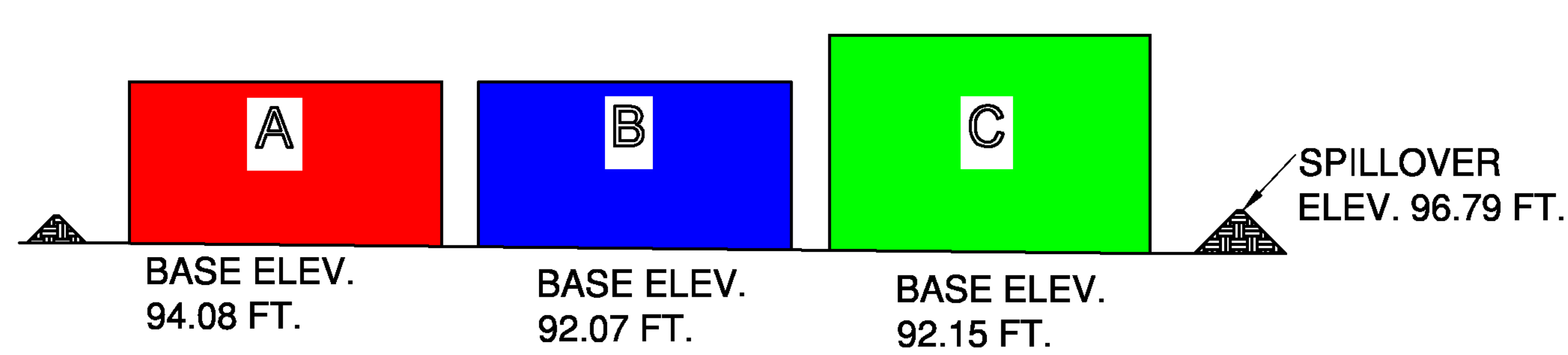
Displacement Volumes of Smaller Tanks



Tank C is largest tank. Displacement Volumes of A & B below spillover elevation must be deducted.

Tank	Diameter (Feet)	Tank Height (Feet)	Tank Volume (Barrels)	Average Tank Base Elevation (Feet)	Dike Spillover Elevation (Feet)	Gross Dike Volume (Barrels)	Tank Displace-ment Volume(s) (Barrels)	Net Dike Volume (Barrels)	Largest Max Fill Tank Volume (Barrels)	Containment Capacity (%)
Combined Tank Areas										
Tanks A, B, and C										
A B C	117 117 120	30 29 40	322,376 311,630 452,160	94.08 92.07 92.15	96.79	125,752	5,187 9,034 NA	111,531	79,704	139.93%

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Dike Construction Materials

- Dike walls should be “sufficiently impervious” and discharges should not escape the containment until cleanup occurs per Section 112.7(c).
- EPA does not specify permeability criteria…ultimately determination of imperviousness should be verified by the certifying P.E.
- Physical determination of sufficient imperviousness for existing dikes
  - Measure holding capacity after rain events
  - Inspect for exterior dike seeps
  - Underside of tanks – native soil testing and travel-time calculations, enhance integrity testing
  - Maintain calculations/engineering justifications on file

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Dike Construction Materials

- Earthen floors may be acceptable if sufficiently impervious and there is no subsurface conduit to navigable waters.
  - Subsurface conduits (e.g., monitoring wells) should be sealed (leak tight caps, bentonite)
- Check State requirements regarding use of native soil as containment floor. Some states may restrict use or require laboratory geotechnical testing prior to approval.

Space Limitations and Utilities

- Completely map or survey available lands and utilities prior to design
- Consider locations of utilities during design
- Review locations of pipelines and on-site utilities with facility personnel

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Plant Operations

- Early and constant communication with facility is very important
- Design should not hinder normal plant operations
- Review conceptual design with facility prior to full design

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Volume Calculations/Other Considerations

- Pre-construction Volume Calculation
  - Apply "sufficient freeboard" to design – check State requirements
  - Verify your design with a volume calculation
  - Apply a factor of safety to the design elevation
- Other Considerations
  - Locate dike drains at topographic low point of containment floor
  - Winch post drainage pipe inlets should be higher than the spillover elevation
  - Concrete walls: Use a water stop at joints (should be compatible with product stored)
  - Squirt factor: Avoid designing dikes immediately adjacent to tank

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Construction Considerations

- Pre-construction testing
- Site Preparation
- Soil placement and compaction
- Construction Quality Assurance (CQA)
- Post-construction Volumes Calculations

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Construction Considerations

- Pre-construction testing
  - Earthen dikes: Proctor curve (moisture-density relationship) to determine optimum compaction
  - Earthen dikes: Re-molded permeability testing
  - Geomembranes: laboratory conformance testing
    - Pre-construction conformance testing per ASTM standards
      - Carbon black content
      - Thickness
      - Density
      - Tear and puncture resistance

Construction Considerations

- Site Preparation
  - Construct dikes on top of prepared subgrades (not gravel zones) to prevent seeps
  - Scarify subgrade prior to placement of soil

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Construction Considerations

- Soil placement and compaction
  - Proper soil compaction should provide dike with sufficient strength and sufficient low permeability
  - Compact to at least 90% of the Standard Proctor (95% recommended)
  - Adjust moisture as needed to stay within acceptable range of optimum moisture content
  - Good engineering practice to achieve 1 x 10^{-7} cm/sec permeability on dikes

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Construction Considerations

- Construction Quality Assurance (CQA)
  - Recommend developing a CQA Plan prior to construction
  - Earthen dikes - Collect in-situ moisture/density tests using a nuclear gauge or equivalent to ensure you are meeting your compaction criteria
  - Concrete: cylinder tests for compressive strength
  - Geomembranes
    - Trial Welds
    - Non-destructive
      - Vacuum box
      - Air pressure testing for wedge welded seams
    - Destructive – laboratory peal and shear tests
- Post-construction survey and volume calculations (as-builts)

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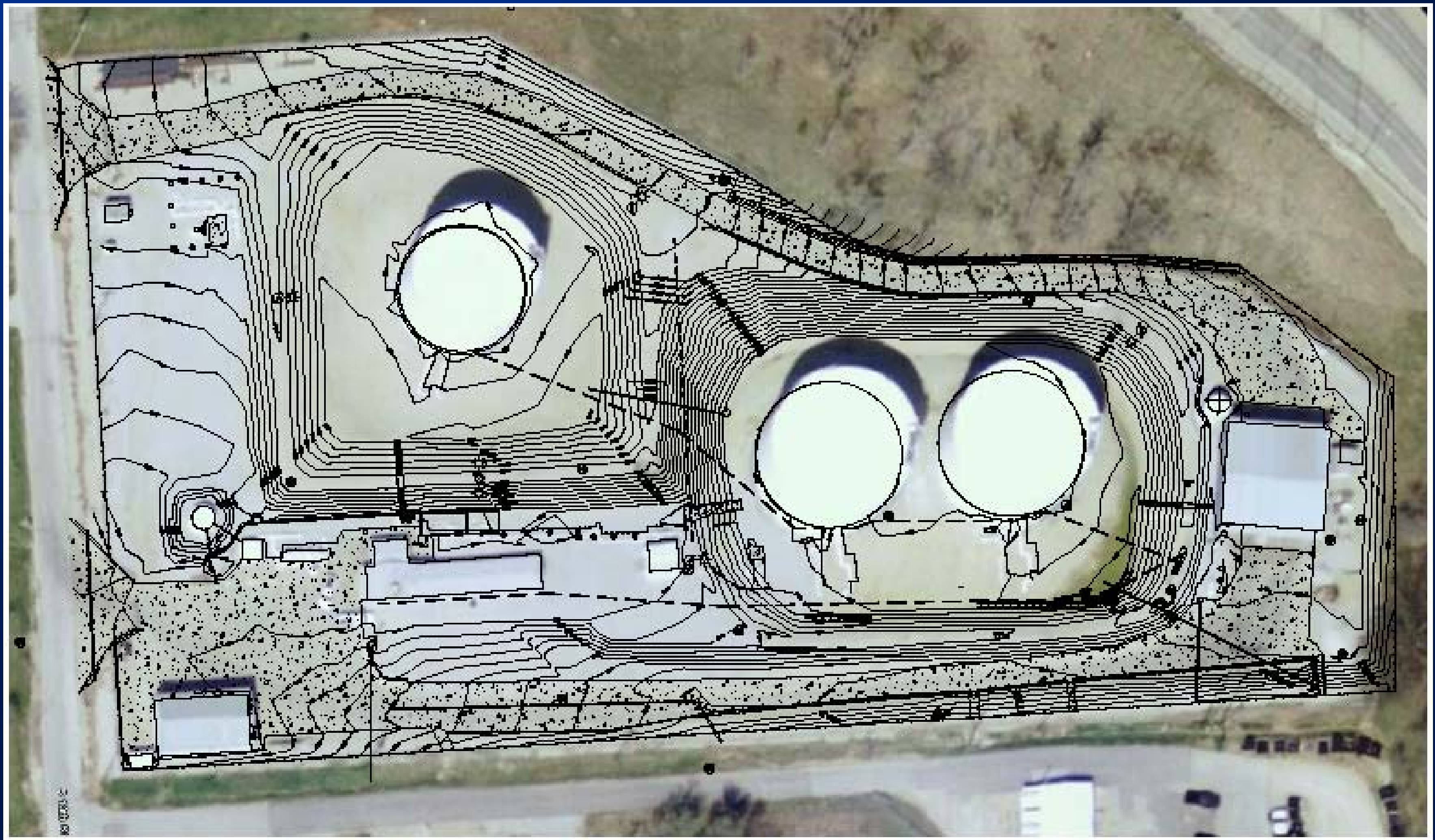
Example Projects

Capehart, Nebraska Pipeline Terminal
Earthen Dike and Retaining Wall



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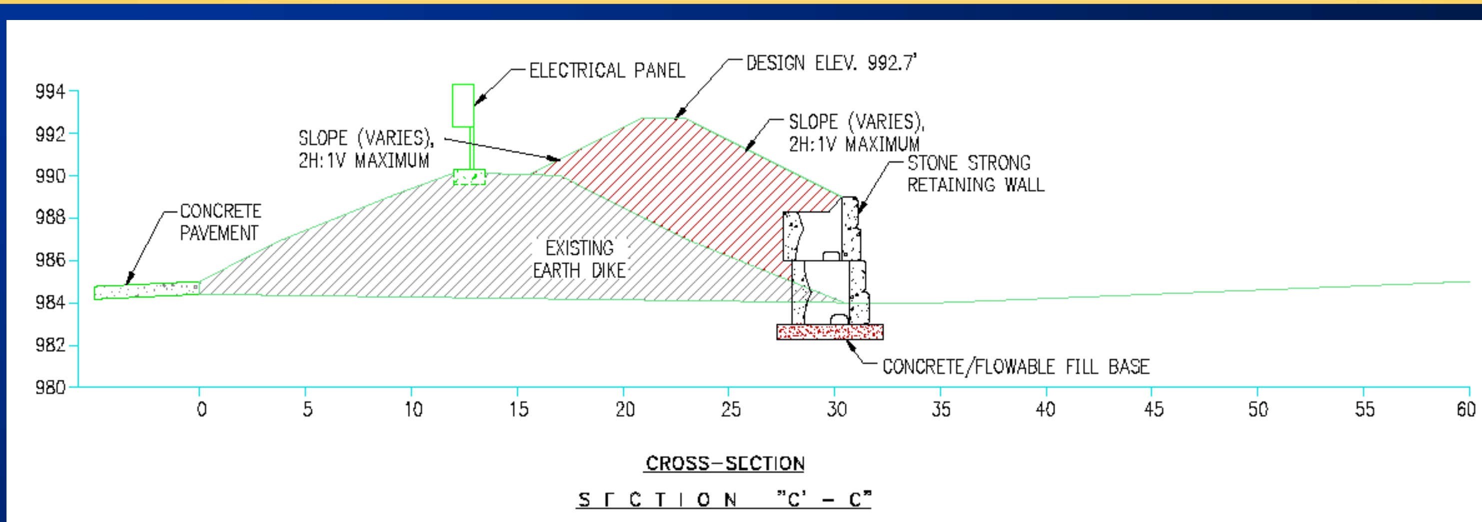
Capehart, Nebraska Pipeline Terminal




Flowable fill base


Flowable fill base

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Capehart, Nebraska Pipeline Terminal

Installation of Retaining Wall Blocks


Installation of Retaining Wall Blocks


Extension of Earthen Dike


Installation of Retaining Wall Blocks

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Final Construction Photos

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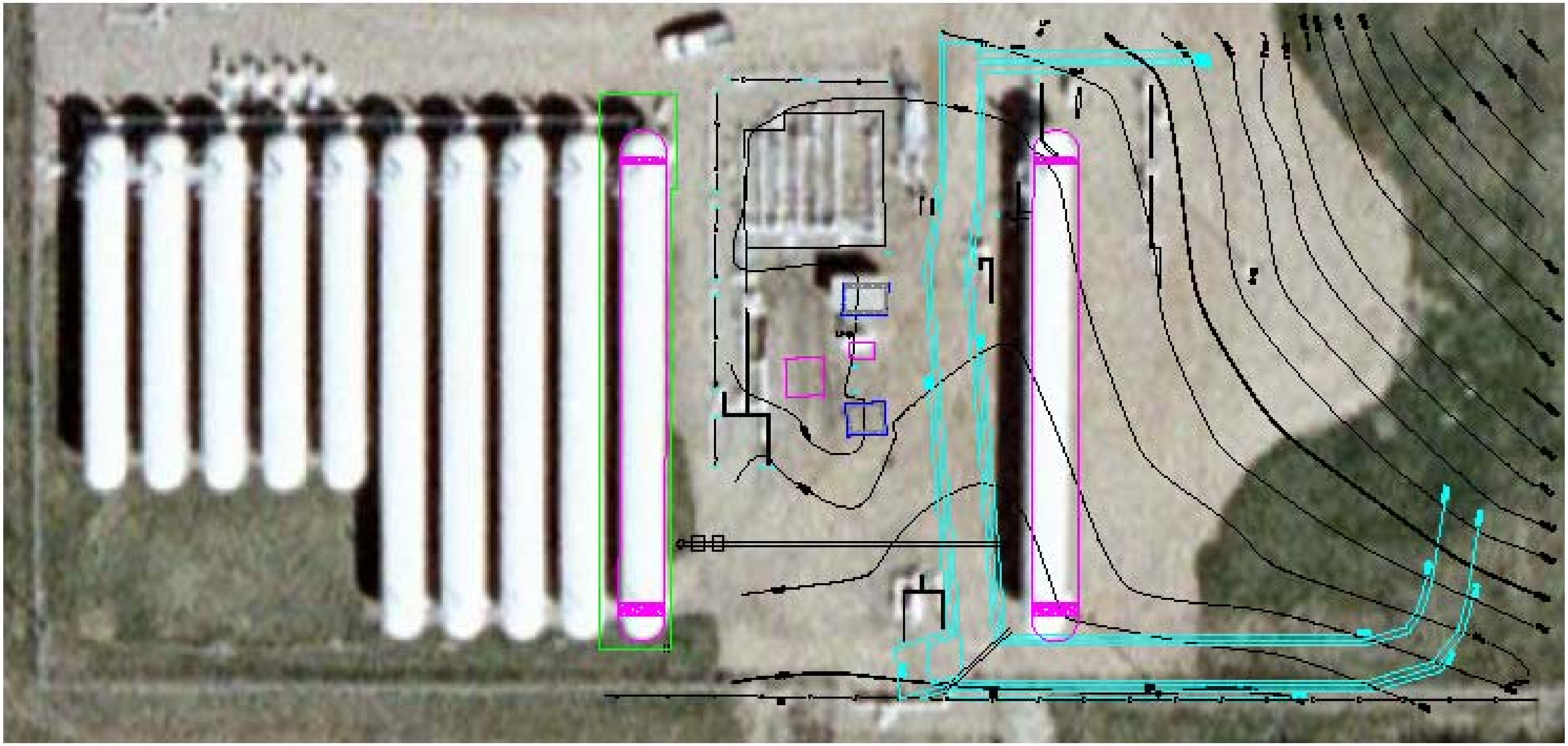
Example Projects

Minneapolis/St. Paul Terminal
Combined Containment System: Earthen Dike and Geomembrane Lined Stainless Steel Wall



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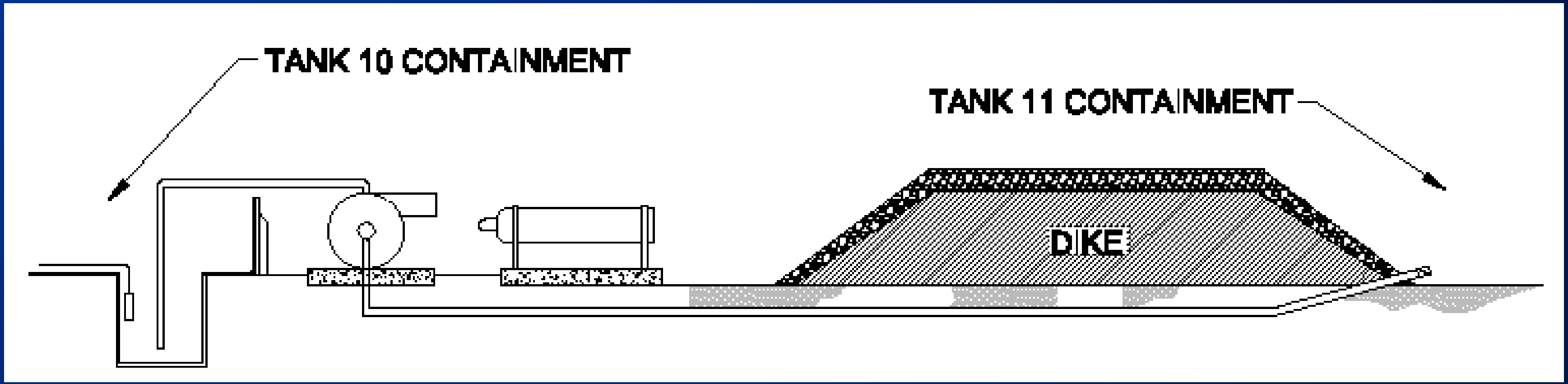
Minneapolis/St. Paul Terminal



Steel Wall Construction

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Minneapolis/St. Paul Terminal


Geomembrane liner placement


Sump system

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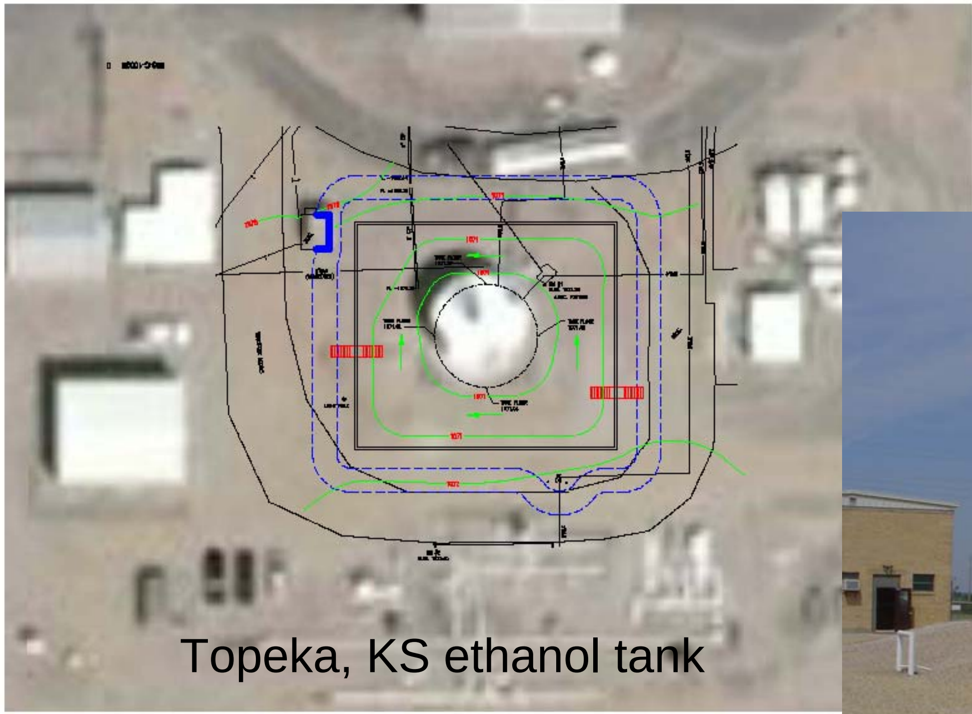
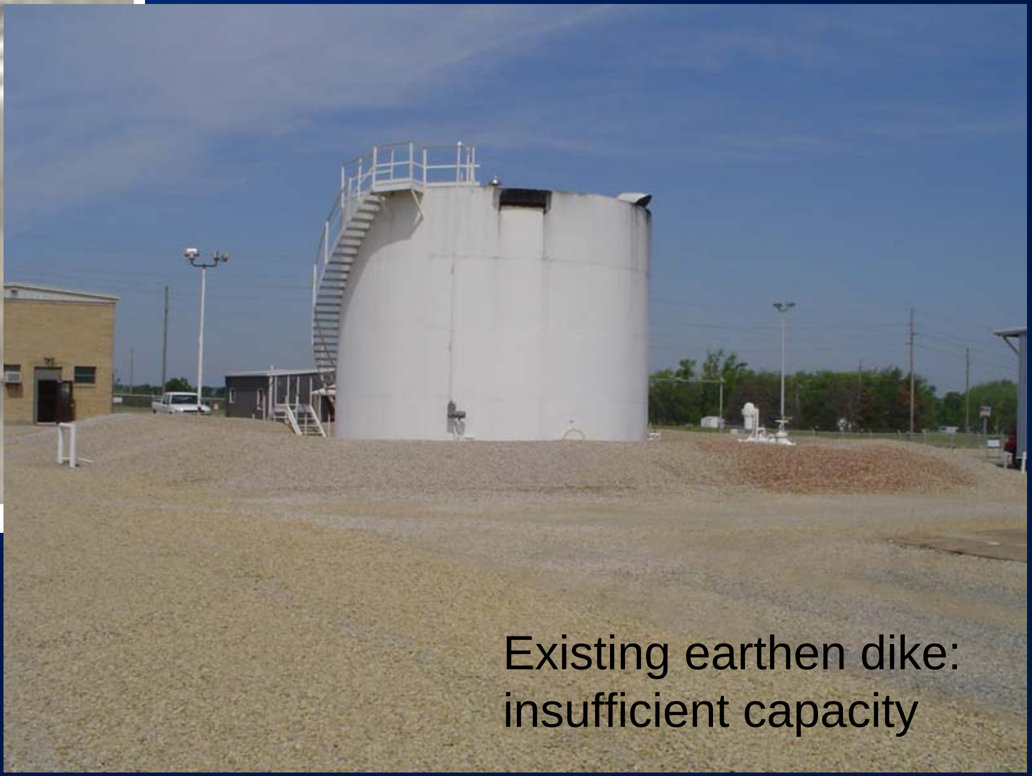
Example Projects

Concrete Wall Systems –Topeka, KS and Waterloo, IA

Space limitations required construction of concrete wall to attain sufficient containment capacity



Topeka, KS ethanol tank



Existing earthen dike: insufficient capacity

Topeka, KS Terminal

Concrete wall constructed to accommodate space limitations (e.g., truck paths and utilities)

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Waterloo, IA Terminal

Waterloo, IA concrete wall vertical extension project


Epoxy placed on top of existing wall


Concrete pouring activities


Completed wall extension

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QUESTIONS?

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