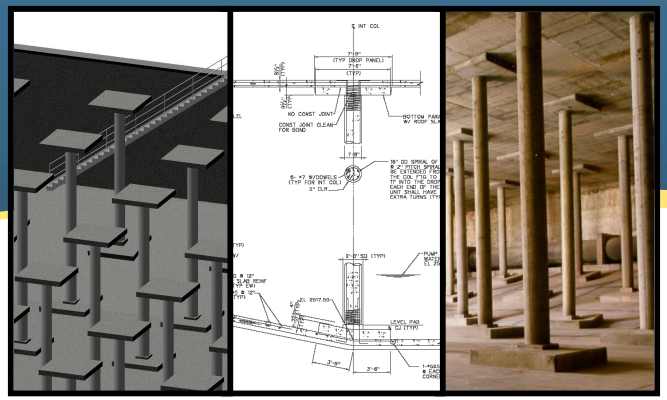
PNWAWWA Conference
April 30, 2008
Vancouver, WA

Beneficial Reuse of Standard Design Details and Criteria



Mark Graham, P.E.

MWH

BUILDING A BETTER WORLD

If I have seen a little further it is by standing on the shoulders of Giants.

- Sir Isaac Newton

A good engineer is a person who makes a design that works with as few original ideas as possible.

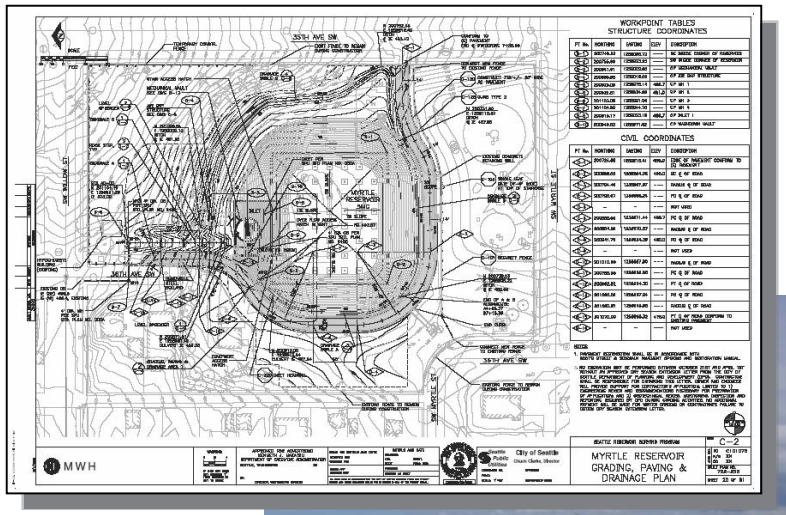
- *Freeman Dyson*

SPU Reservoir Burying Program

Seattle Public Utilities

MWH

R.W. Beck
ECS/TtKCM
Moore Engineering
Beyaz & Patel



Myrtle Reservoir

Program includes conversion of four open reservoirs to buried tanks

Reservoir	Volume	Depth	Status
Beacon Hill	50 MG	26 ft	Construction completion 10/08
Myrtle	5 MG	27 ft	Construction completion 6/08
West Seattle	30 MG	20 ft	Construction NTE anticipated 5/08
Maple Leaf	60 MG	25 ft	Construction NTE anticipated 5/09

Maple Leaf Reservoir

West Seattle Reservoir

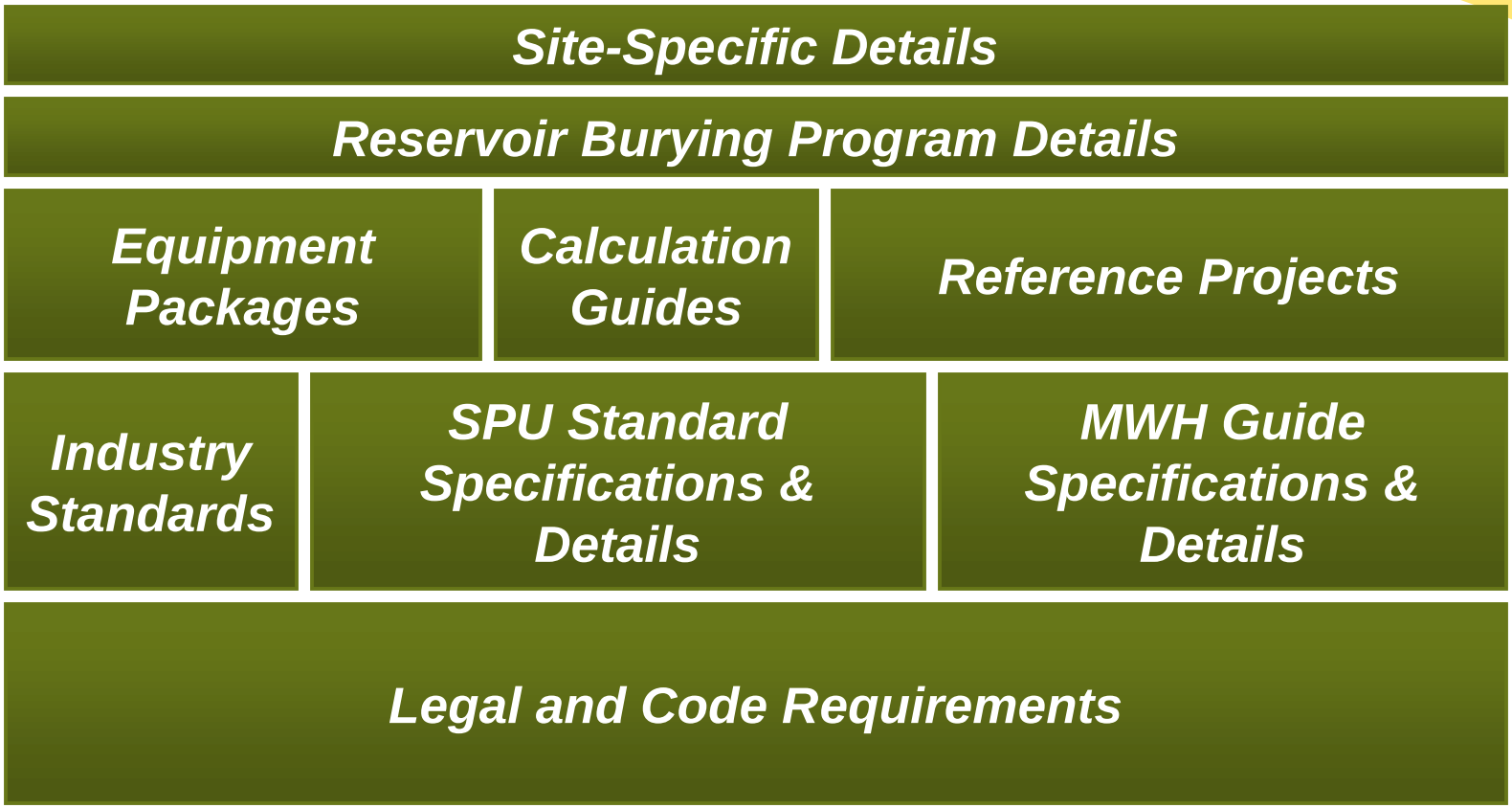
Reservoirs similar in many respects

- Replacing existing open, grade-level reservoirs
- Rectangular, hopper bottom
- Cast-in-place concrete
- Area above reservoir will become public park

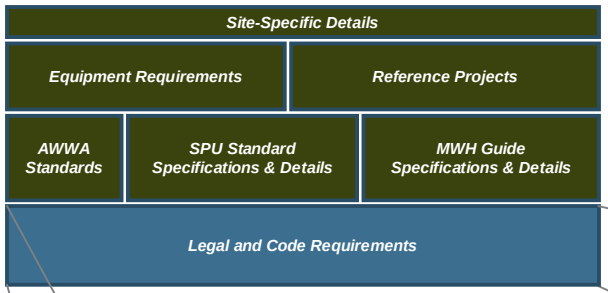
Each reservoir has unique site-specific requirements

- **Beacon Hill Reservoir:** fully-funded Park program
- **Maple Leaf Reservoir:** two 30 MG cells
- **Myrtle Reservoir:** new hypochlorite generation system
- **West Seattle Reservoir:** downsizing reservoir from 68 to 30 million gallons

A thin layer of original work is built upon a deep foundation of prior art



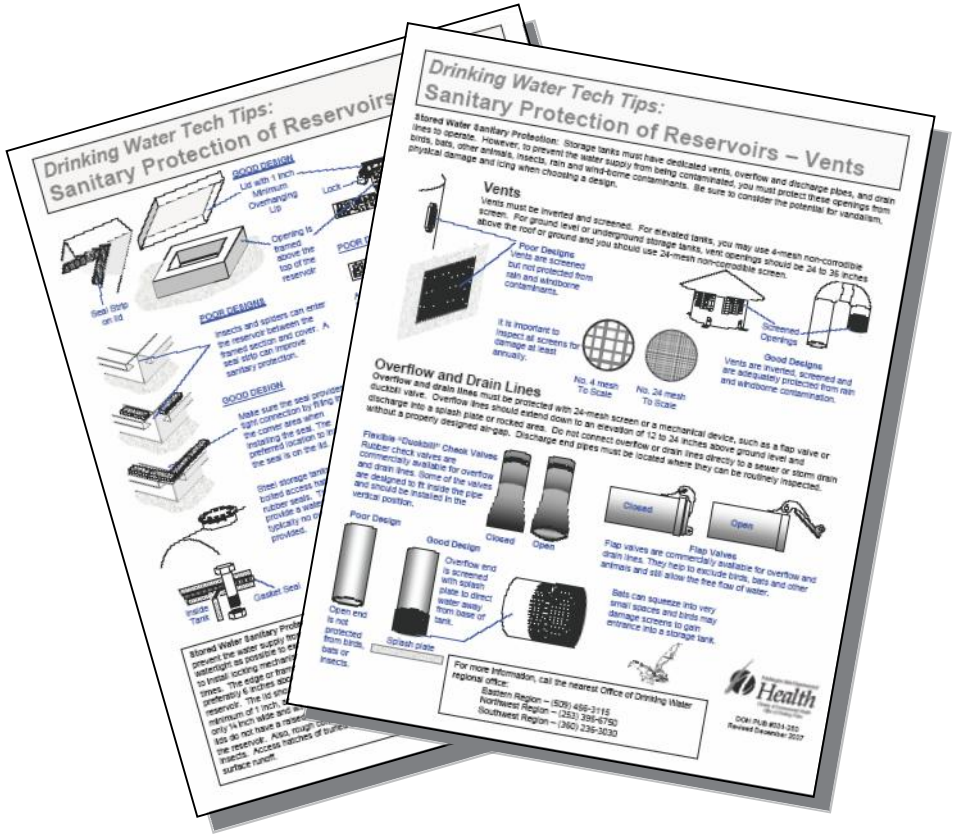
Code requirements take the fun away (and a lot of the risk, too)



If you rely on references to codes in your design, be sure that the Contractor and Resident Engineer have ready access to the codes.

- ***International Building Code***
- ***ACI 318 – Structural Concrete***
- ***ACI 350 – Seismic Design of Liquid-Containing Concrete Structures***
- ***National Electrical Code***
- ***Stormwater, Grading and Drainage Control Code***
- ***ACI 117 – Standard Tolerance for Concrete Construction and Materials***
- ***Department of Labor & Industries***

Department of Health Standards establish minimum requirements for public safety



- Protection against intrusion into reservoirs by insects and rodents
- Prevention of backflow
- Security against intruders

Industry standards establish minimum levels of quality and functionality

ANSI Standards	AWWA Standards	ASTM Standards
• Flanges • Pump Testing	• Valves • Piping	• Steel • Cement • Concrete admixtures • Steel

AASHTO *AISC*

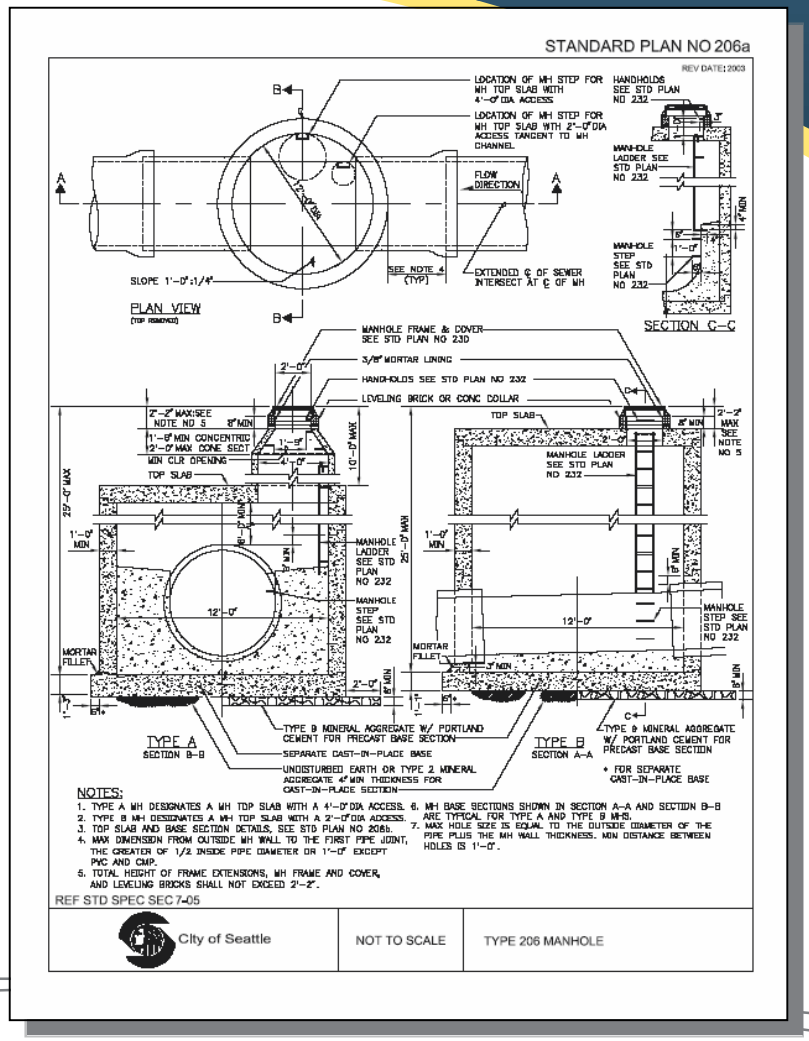
NSF *Hydraulics Institute* *IEEE*

NEMA *NACE* *ASHRAE* *AWS*

In some cases, compliance with specific industry standards is required by code.

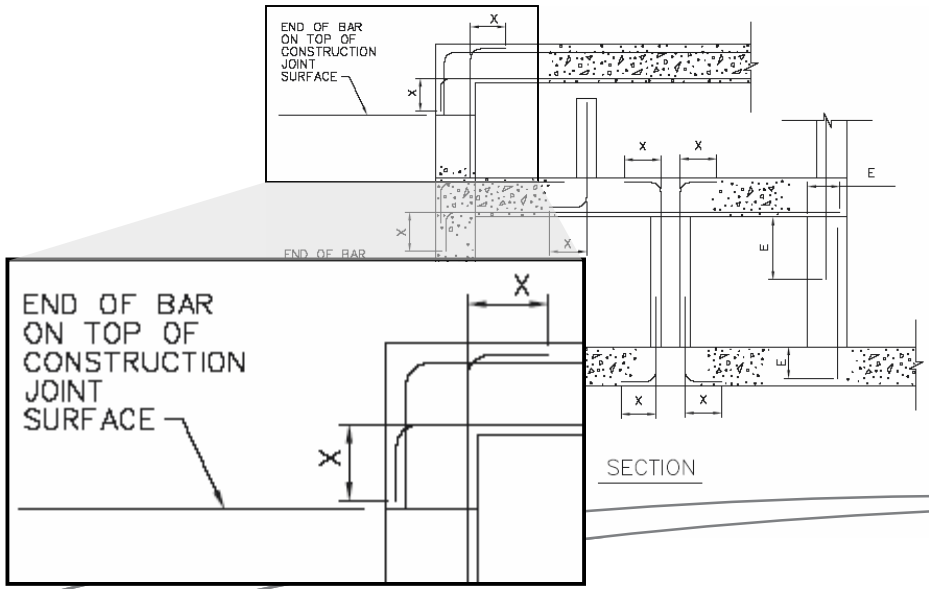
SPU Standards provide uniformity with other projects built in Seattle

- Standard details and specifications referenced in and bound into bid documents
- Used as primary design source for drainage, streets, and traffic improvements



MWH Guide Specifications and Standard Details

- Developed for use in projects throughout the United States
- Use generic dimensions, and may require calculations by Engineer or Contractor



LENGTH (*)			
BAR SIZE	HOOK X	LAP	EMBEDMENT E
#3	6"	16" (21")	12" (16")
#4	8"	16" (21")	12" (16")
#5	10"	20" (26")	15" (20")
#6	12"	28" (37")	22" (28")
#7	14"	48" (62")	37" (48")
#8	16"	62" (81")	48" (62")
#9	19"	79" (102")	61" (79")
#10	22"	100" (130")	77" (100")
#11	24"	123" (160")	95" (123")

* USE LENGTH IN PARENTHESIS FOR WALL HORIZONTAL REBARS AND SLAB BARS WITH 12" OR MORE OF FRESH CONCRETE UNDERNEATH

NOTES:

1. USE LAP LENGTHS AS DETERMINED FROM THESE TABLES UNLESS SHOWN OTHERWISE
2. THE TABLES SHOWN ARE FOR f'c=4000psi, fy=60,000psi, 1.5" MIN CONCRETE COVER AND 3" MIN BAR SPACING
3. MULTIPLY THE LAP AND E SHOWN IN THESE TABLES BY 1.5 FOR EPOXY COATED REINFORCING
4. WHEN BARS OF DIFFERENT SIZES ARE LAP SPLICED, LAP LENGTH SHALL BE THE LARGER OF:
   EMBEDMENT LENGTH OF LARGER BAR
   LAP LENGTH OF SMALLER BAR
5. UNLESS NOTED OTHERWISE USE REBAR COUPLERS FOR SPLICES OF #11 AND LARGER BARS
6. ALL DOWEL BARS SHALL EXTEND AN EMBEDMENT LENGTH E INTO ANOTHER MEMBER OR ACROSS A CONSTRUCTION JOINT UNLESS SHOWN TO SPLICE WITH OTHER BARS OR TO EXTEND TO THE FAR FACE OF THE MEMBER AND END WITH A STANDARD HOOK

SECTION

STANDARD 90° BAR HOOKS, EMBEDMENT LENGTHS AND LAP LENGTHS

REV 091003

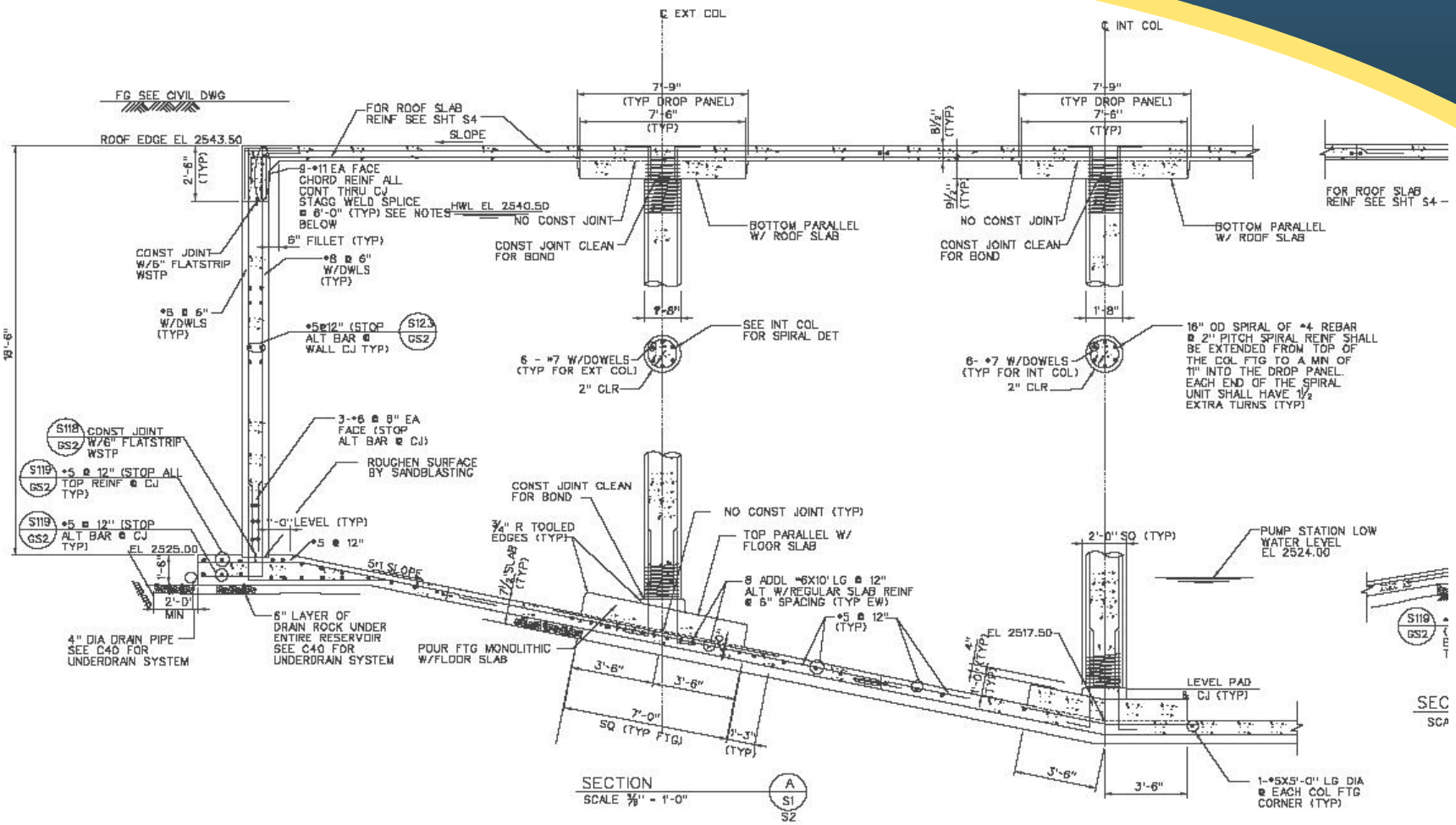
S-143

Reference projects provided starting points for program- and site-specific details

- Lincoln Reservoir
- Magnolia Manor Reservoir
- Eastside Reservoir
- Mt Tabor Reservoirs
- Bitter Lake Reservoir
- 60% Designs for Floating Covers over Existing Reservoirs
- Tropical 2438 Zone Reservoir
- Powell Butte Reservoir
- And many more…

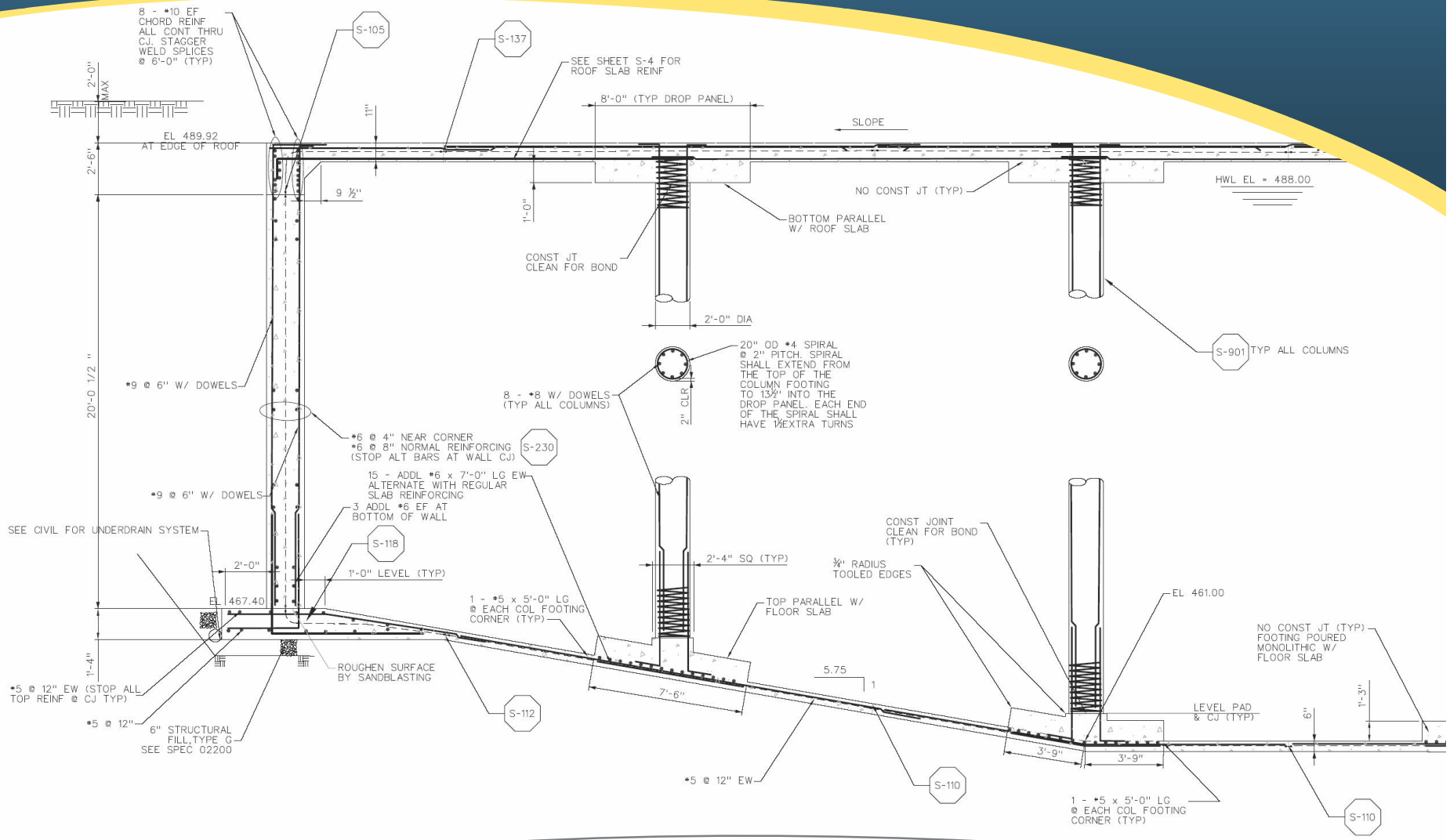
Tropical 2538 Zone Reservoir

(MWH Design for Las Vegas Valley Water District)



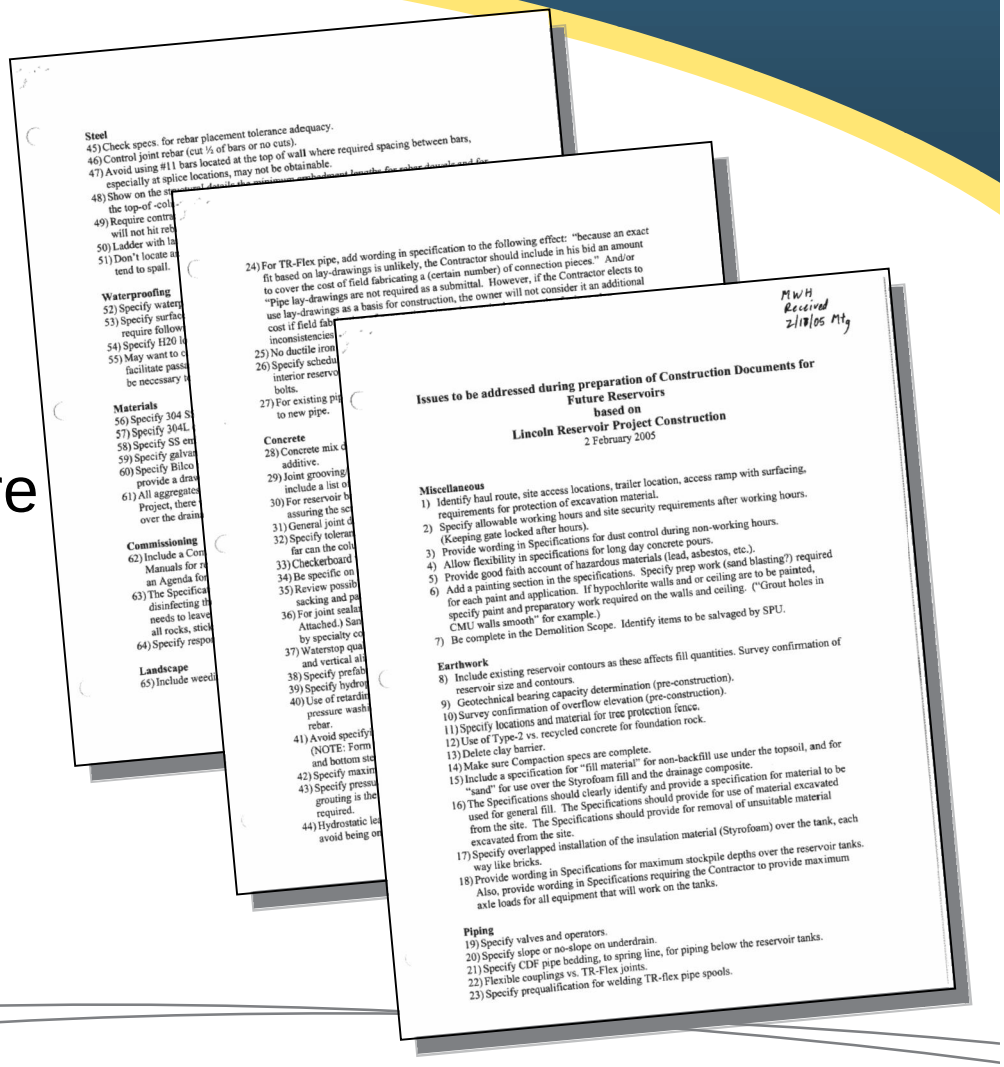
Myrtle Reservoir

(MWH Design for Seattle Public Utilities)



Capture and implementation of lessons learned improves subsequent designs

- Lessons learned documented from Lincoln Reservoir design and construction
- Project managers from previous MWH designs were interviewed
- RFIs, Design Changes and Field Memos from first projects were reviewed for potential incorporation into ongoing designs



Steel
45) Check specs. for rebar placement tolerance adequacy.
46) Control joint rebar (cut ½ of bars or no cuts).
47) Avoid using #11 bars located at the top of wall where required spacing between bars, especially at splice locations, may not be obtainable.

Waterproofing
52) Specify water
53) Specify surfac require follow
54) Specify H20
55) May want to facilitate pass be necessary

Materials
56) Specify 304 S
57) Specify 304L
58) Specify SS en
59) Specify galvan
60) Specify Bilco provide a draw
61) All aggregates Project, there over the drain

Commissioning
62) Include a Cor Manuals for an Agenda for
63) The Specifica disinfecting th needs to leave all rocks, stick
64) Specify respo

Landscape
65) Include weedi

24) For TR-Flex pipe, add wording in specification to the following effect: "because an exact fit based on lay-drawings is unlikely, the Contractor should include in his bid an amount to cover the cost of field fabricating a (certain number) of connection pieces." And/or "Pipe lay-drawings are not required as a submittal. However, if the Contractor elects to use lay-drawings as a basis for construction, the owner will not consider it an additional cost if field fab
inconsistencies
25) No ductile iron
26) Specify schedu interior reservo bolts.
27) For existing pi to new pipe.

Concrete
28) Concrete mix d additive.
29) Joint grooving include a list o
30) For reservoir b assuring the sc
31) General joint d
32) Specify toleran for can the col
33) Checkerboard
34) Be specific on
35) Review possib sacking and pa
36) For joint sealar Attached.) San by specialty co
37) Waterstop qua and vertical al
38) Specify prefab
39) Specify hydro
40) Use of retardin pressure wash rebar.
41) Avoid specify (NOTE: Form and bottom ste
42) Specify maxim
43) Specify pressu grouting is the required.
44) Hydrostatic te avoid being or

MWH
Received
2/18/05 Mtg

Issues to be addressed during preparation of Construction Documents for Future Reservoirs based on Lincoln Reservoir Project Construction
2 February 2005

Miscellaneous
1) Identify haul route, site access locations, trailer location, access ramp with surfacing, requirements for protection of excavation material.
2) Specify allowable working hours and site security requirements after working hours. (Keeping gate locked after hours).
3) Provide wording in Specifications for dust control during non-working hours.
4) Allow flexibility in specifications for long day concrete pours.
5) Provide good faith account of hazardous materials (lead, asbestos, etc.).
6) Add a painting section in the specifications. Specify prep work (sand blasting?) required for each paint and application. If hypochlorite walls and or ceiling are to be painted, specify paint and preparatory work required on the walls and ceiling. ("Grout holes in CMU walls smooth" for example.)
7) Be complete in the Demolition Scope. Identify items to be salvaged by SPU.

Earthwork
8) Include existing reservoir contours as these affects fill quantities. Survey confirmation of reservoir size and contours.
9) Geotechnical bearing capacity determination (pre-construction).
10) Survey confirmation of overflow elevation (pre-construction).
11) Specify locations and material for tree protection fence.
12) Use of Type-2 vs. recycled concrete for foundation rock.
13) Delete clay barrier.
14) Make sure Compaction specs are complete.
15) Include a specification for "fill material" for non-backfill use under the topsoil, and for "sand" for use over the Styrofoam fill and the drainage composite.
16) The Specifications should clearly identify and provide a specification for material to be used for general fill. The Specifications should provide for use of material excavated from the site. The Specifications should provide for removal of unsuitable material excavated from the site.
17) Specify overlapped installation of the insulation material (Styrofoam) over the tank, each way like bricks.
18) Provide wording in Specifications for maximum stockpile depths over the reservoir tanks. Also, provide wording in Specifications requiring the Contractor to provide maximum axle loads for all equipment that will work on the tanks.

Piping
19) Specify valves and operators.
20) Specify slope or no-slope on underdrain.
21) Specify CDF pipe bedding, to spring line, for piping below the reservoir tanks.
22) Flexible couplings vs. TR-Flex joints.
23) Specify prequalification for welding TR-flex pipe spools.

Program standards were developed for use at all four reservoirs

- Design criteria database compiled during preliminary design
- Specifications developed for Beacon Hill and Myrtle Reservoirs were recycled for use at West Seattle and Maple Leaf Reservoirs
- Common details and design concepts were used for:
  - Structural system
  - Mechanical equipment
  - P&IDs / Control systems
  - Mechanical vault layout

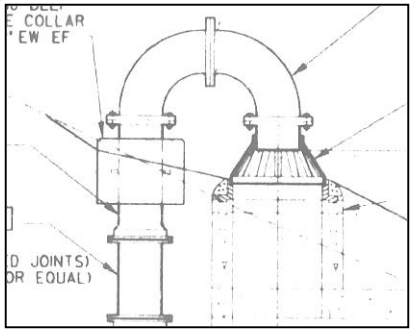
Standard mechanical vault design

- 30’ inside diameter vault designed to accommodate mechanical equipment at all four reservoirs.
- Recirculation pumps
- Seismically-actuated outlet valves

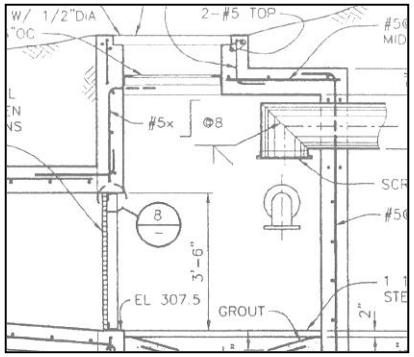
Common design criteria among all four pumped recirculation systems

- Operations are identical at all four reservoirs, and very similar to operations at other SPU reservoirs
- Standard sizes allow interchangeability among recirculation pumps at different sites
  - Pumps at Myrtle Reservoir and West Seattle Reservoir are interchangeable
  - Pumps at Beacon Hill Reservoir and Maple Leaf Reservoir are interchangeable

Design Detail Evolution – Air Gap Structure

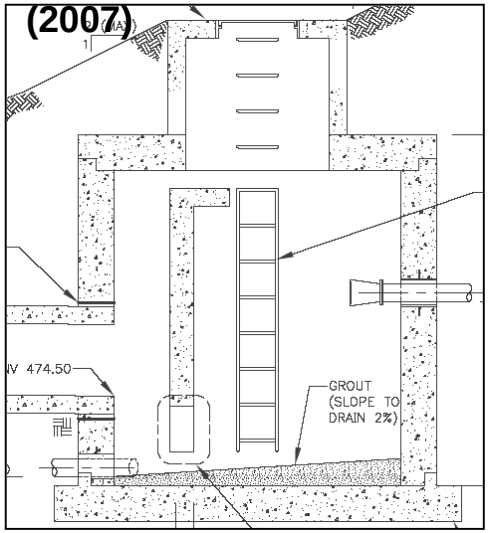


Magnolia Manor Reservoir (1994)

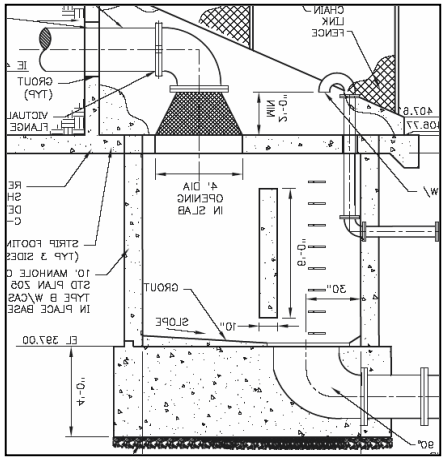


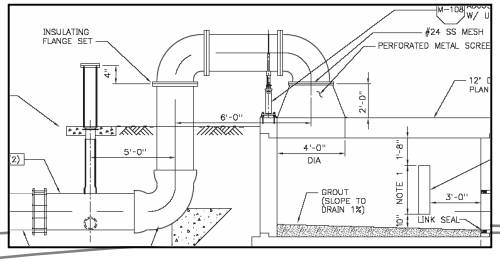
Lincoln Reservoir (2002)

Myrtle Reservoir (2007)



West Seattle Reservoir (2008)





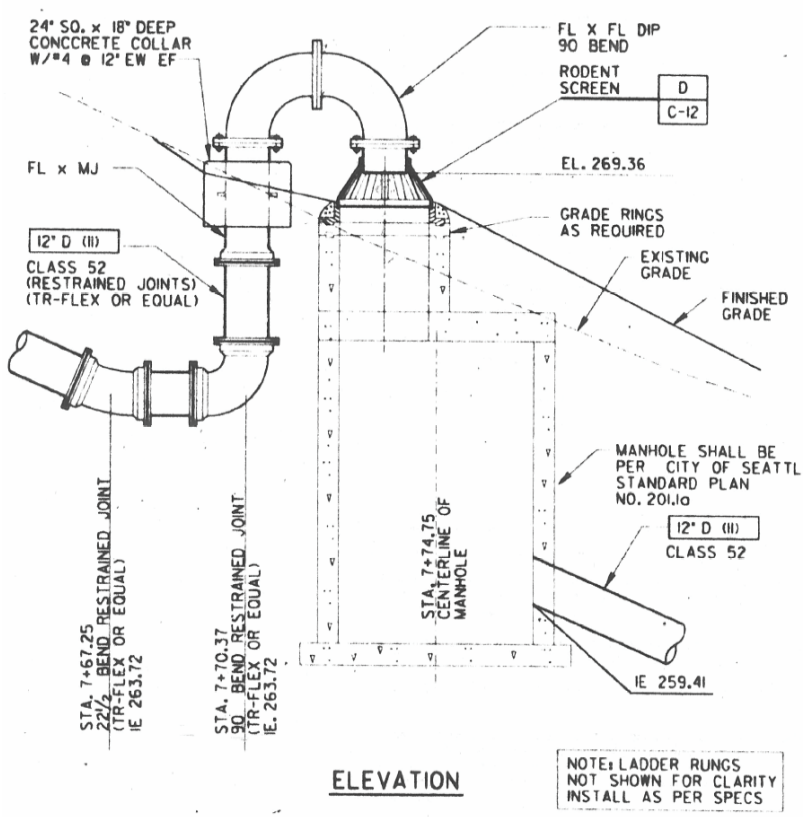
Trenton Standpipes (2008)

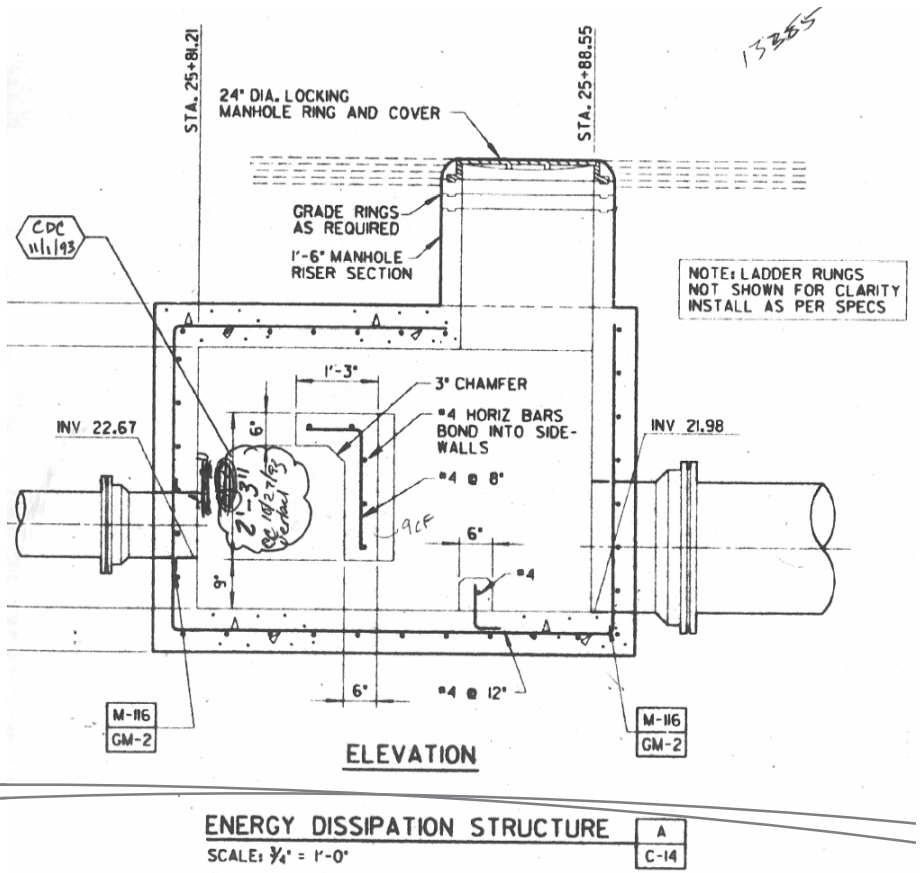
?

Maple Leaf Reservoir (2009)

Gooseneck air gap and energy dissipation structures at Magnolia Manor Reservoir (1994)

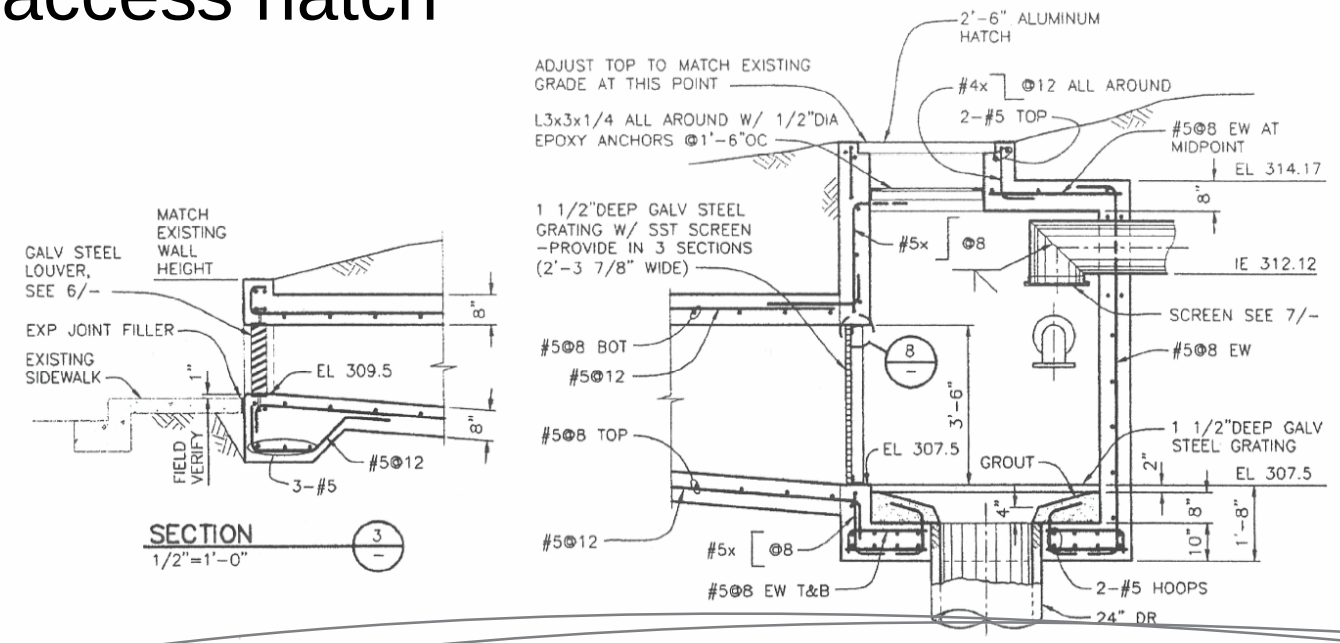
- Air gap near overflow
- Energy dissipation structure on drain





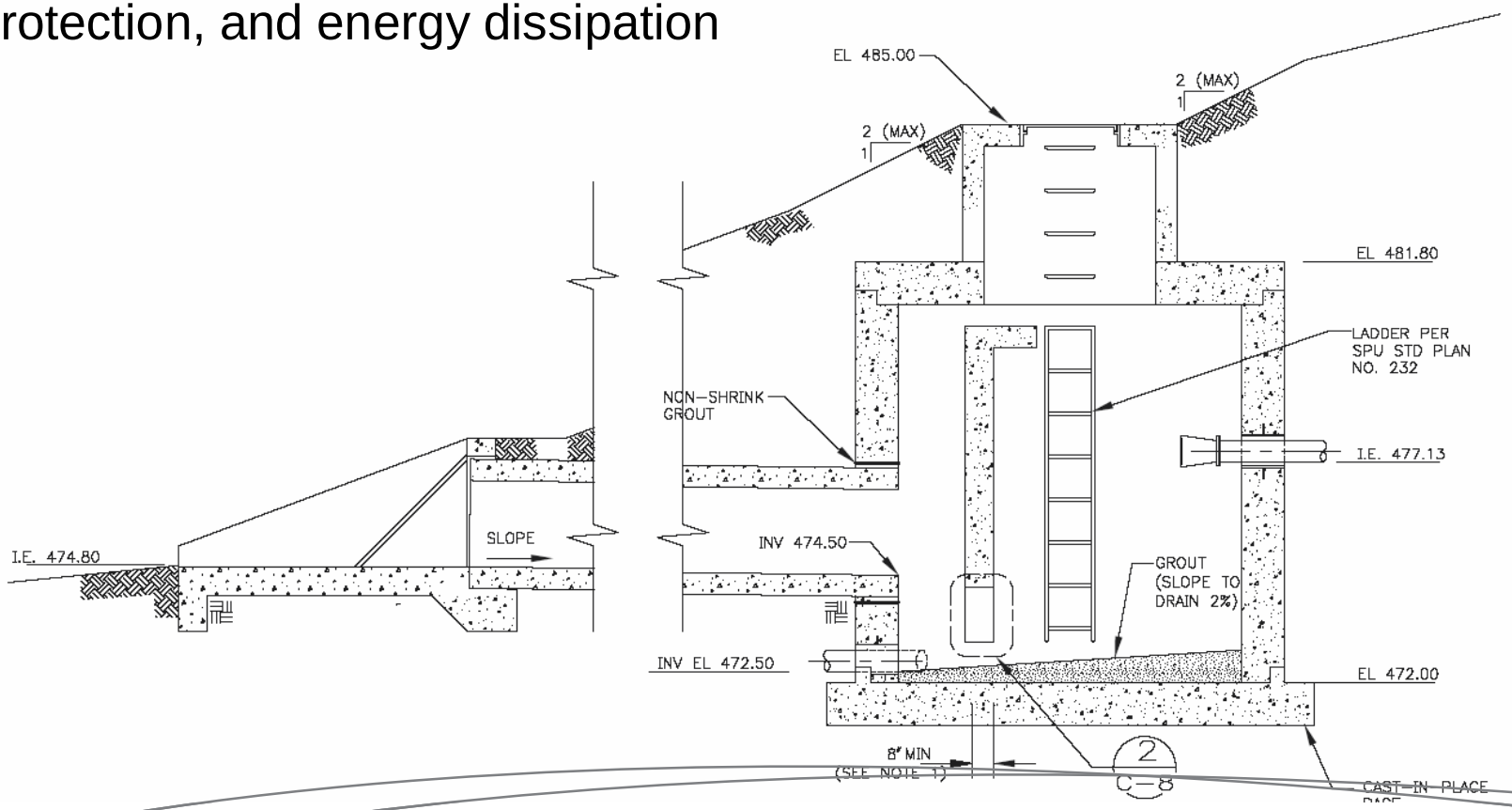
Low-profile air gap structure at Lincoln Reservoir (2002)

- Design solution for minimal available head, installation within public park.
- Only visible features are louver within retaining wall and access hatch



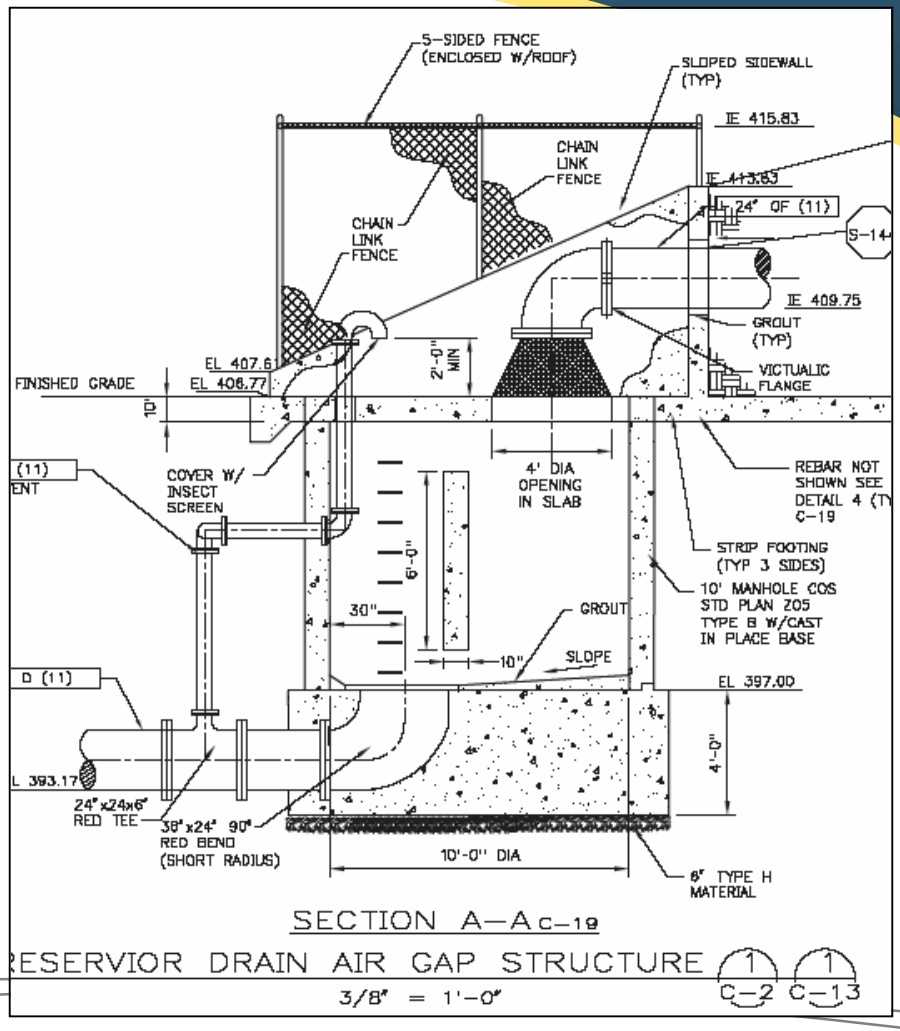
Low-profile, energy dissipating air gap structures at Myrtle and Beacon Hill Reservoirs (2007)

- Design solution combines minimal visual impact, air gap backflow protection, and energy dissipation



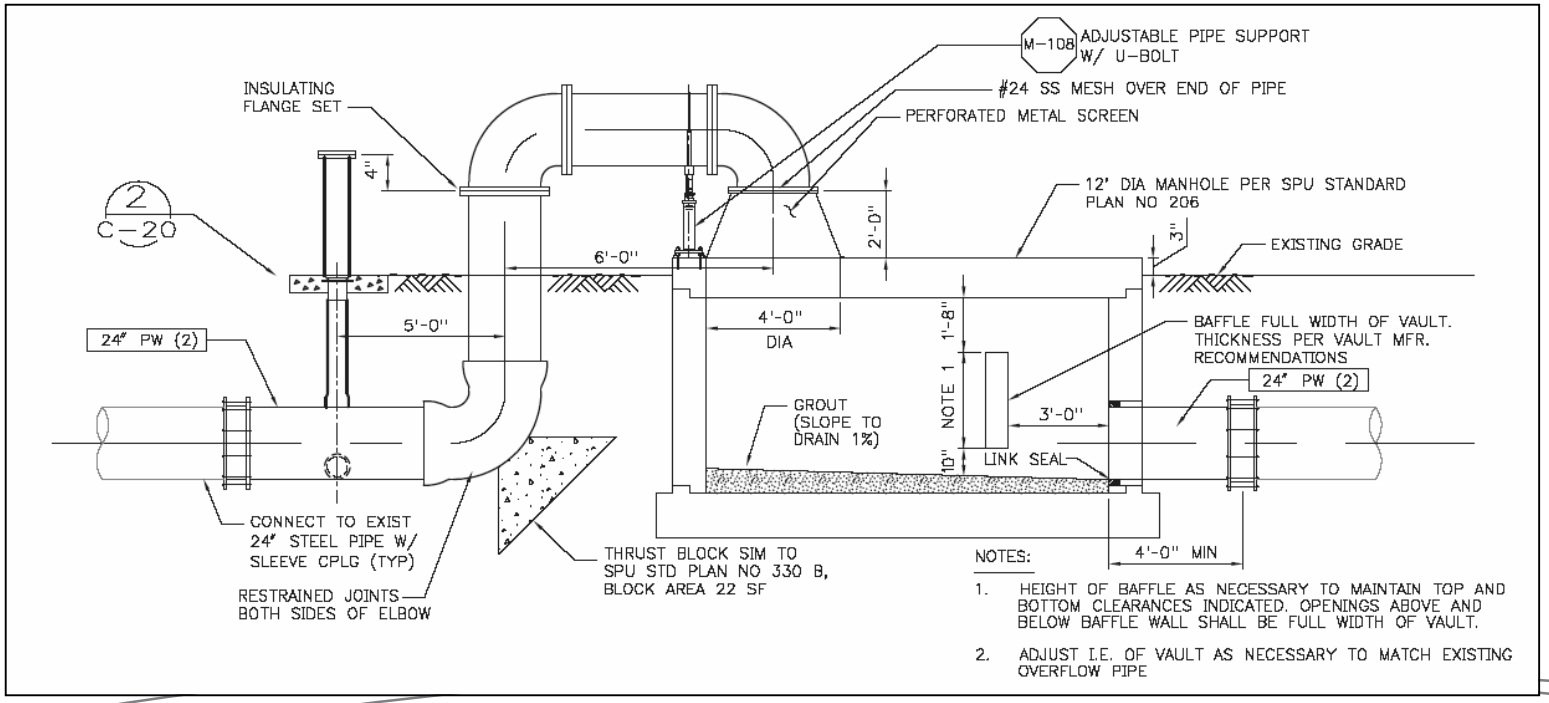
Air Gap at West Seattle Reservoir provides for visibility of overflow

- Design for energy dissipation and visibility of reservoir overflows
- Remote location makes noise and aesthetics less important



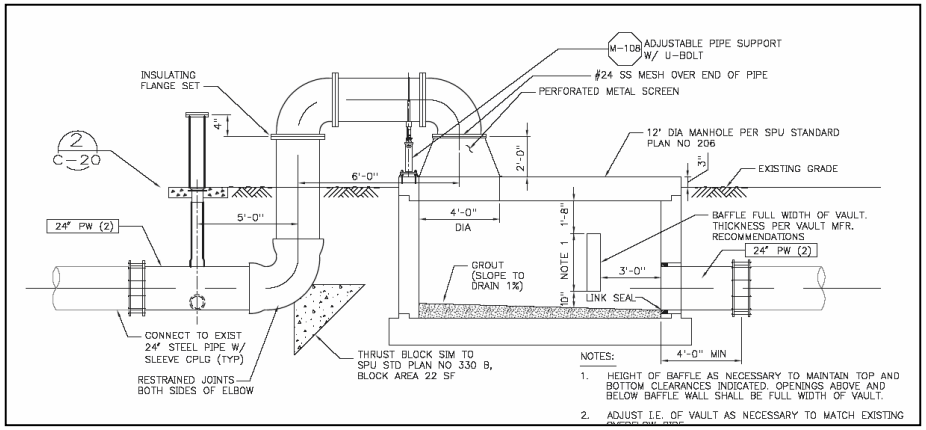
Gooseneck Air Gap selected for use at Trenton Standpipes

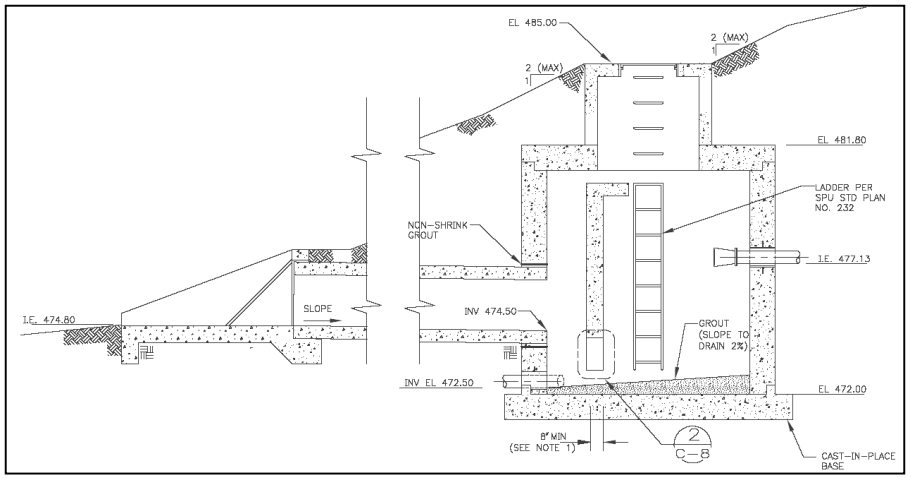
- Air Gap structure cut into existing overflow/ drain piping



Air Gap design at Maple Leaf still under development

- Lower visual impact of buried air gap structure
- Tree removal required for buried air gap structure in slope may drive air gap to flat portion of site





Experience is the name every one gives to their mistakes.

- Oscar Wilde

Benefits of Standardization

- Improved design and construction quality
- Design cost savings
- More efficient O&M

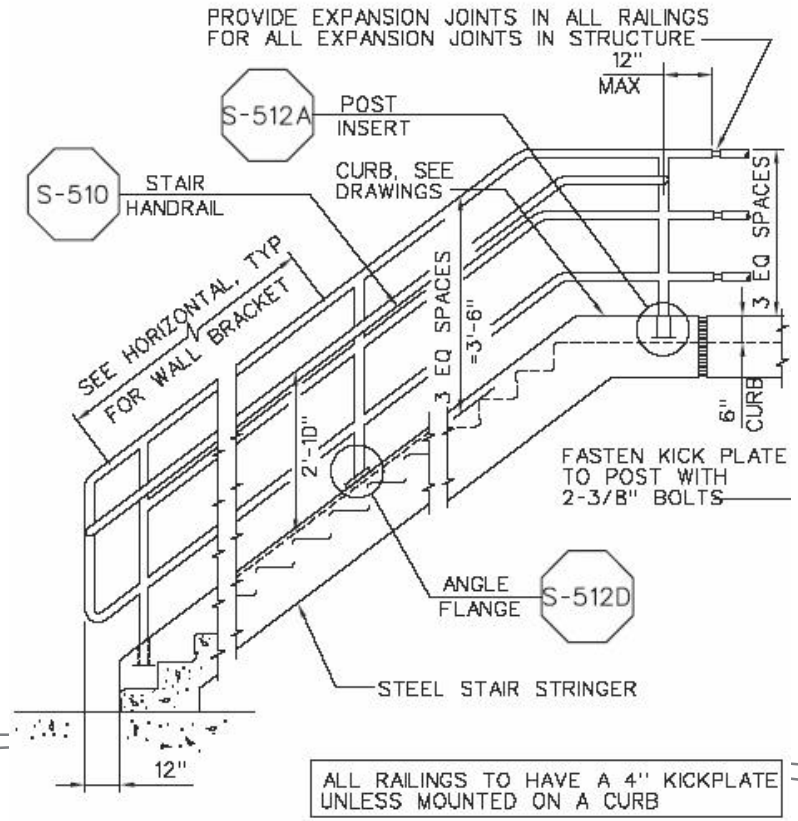
Risks of Standardization

- Over-design for application
- Uncritical (and therefore improper) use

Standard details must evolve with changes in codes and industry standards…

… and the design engineers are responsible for assuring that they do!

MWH Standard Detail for handrail was updated for Beacon Hill Reservoir design



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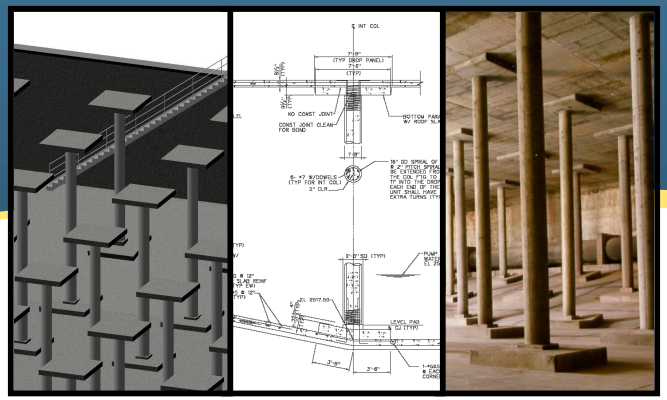

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