Solano Irrigation District

Successes, Challenges, and Lessons Learned on Agricultural Pipeline Replacements

Northern California Pipe Users
Group Annual Seminar

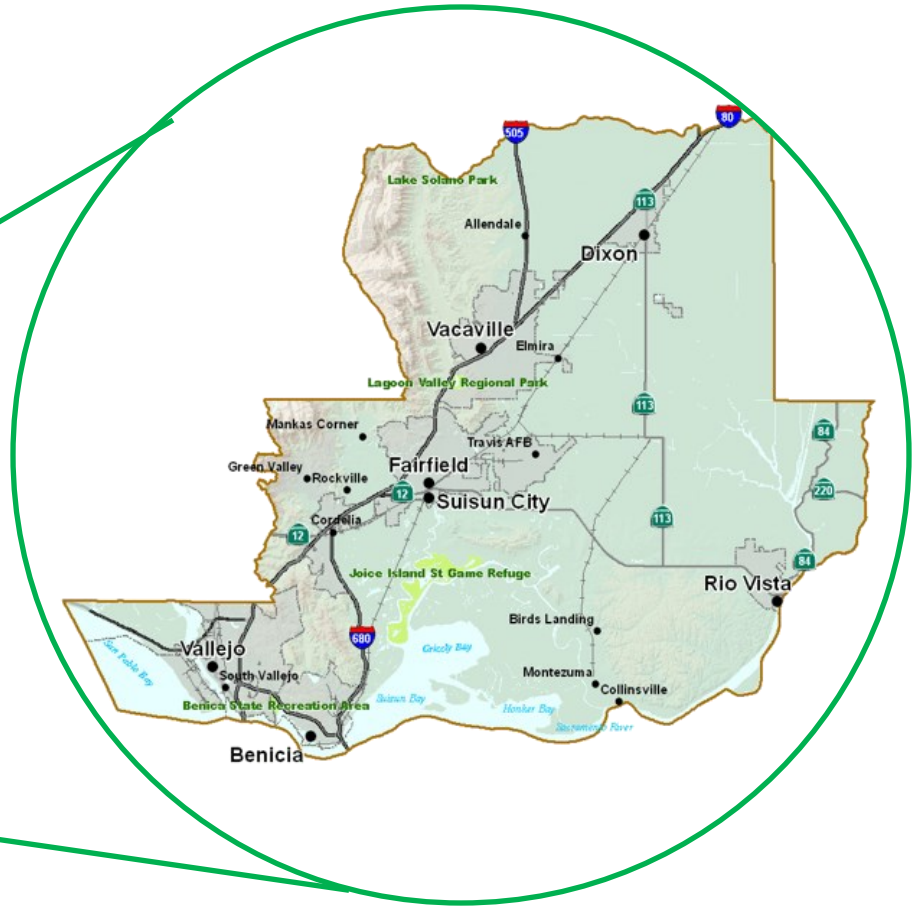
February 13, 2025

Coastland | DCCM

Agenda

- About Solano Irrigation District
- Pipeline Replacement Program
- Design Considerations
- Construction Challenges & Successes
- Costs
- Lessons Learned

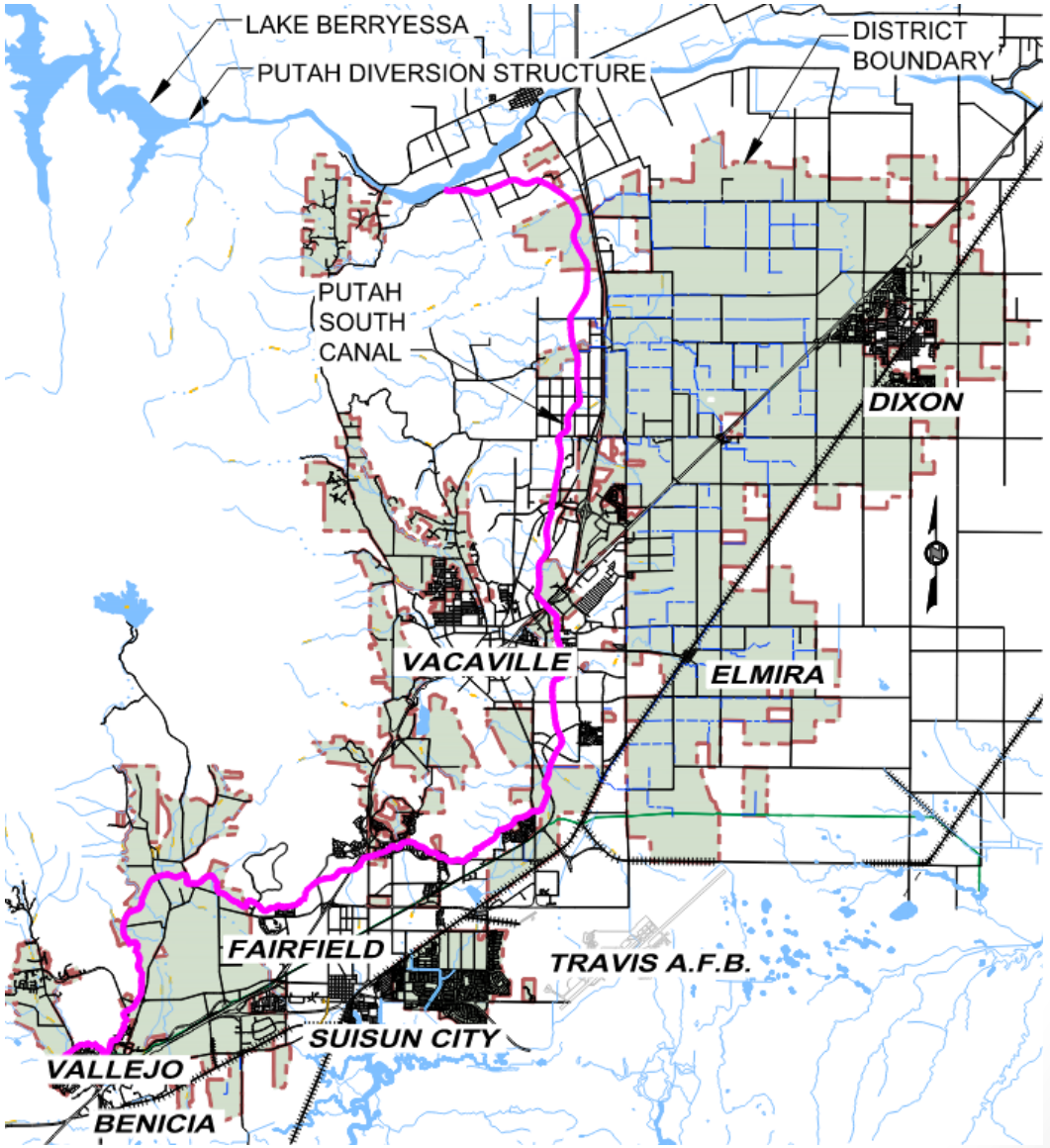
Location



Solano County is between Sacramento and San Francisco Bay Area

About Solano Irrigation District

- Untreated water for Benicia, Vacaville, Fairfield, and Vallejo serving a resident population of more than 300,000
- Seven Public Water Systems ranging from 10 to 8,000 services
- 141,000 acre-feet of irrigation water
- 59,000 acres of irrigable land
- 112 miles of canals
- 186 miles of pipeline
- All constructed circa 1961, concrete pipe



Rehabilitation & Betterment

- R&B Program: mechanism for upgrades and replacement for all irrigation facilities
- Legally restricted funds from property assessments
- Annual budget ~$4M
- Historically all design and construction work performed by in-house staff

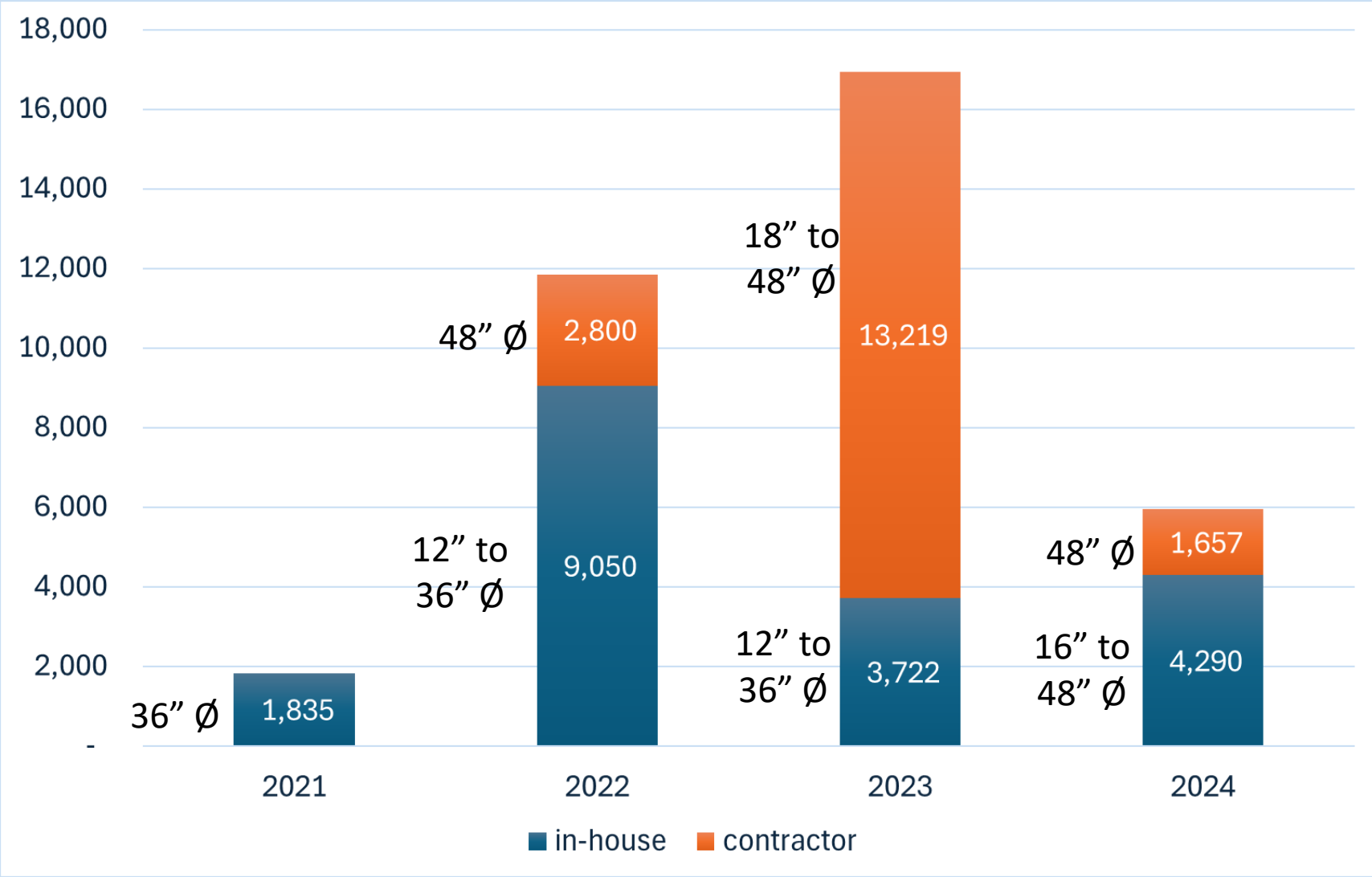
2025 Rehabilitation & Betterment Program Budget

Work Order	R&B No.	Distribution Project	Project Description	2025 R&B Budget
19-2946	C.127	Brazelton Lateral Relocation due to Farrell Rd at Gibson Canyon Rd Intersection Reconstruction	Install approximately 50 feet of 30" pipe and reconnect to two laterals	$ 99,200
21-3062	C.110.a	Vaugh Lateral 5 Pipeline Silveyville to TO 7	Replace 1390 feet of 42" MCP with 42" PVC	$ 935,500
21-3177	C.96.b	Pierce Lateral B Headworks to Turnout 2	Install 700 lf of 30" pipeline in a new alignment	$ 125,000
23-3320	C.13	Weyand Upper Pipeline (TO 1A to Porter Road)	Replace 1,600 ft of 48" pipeline	$ 11,000
23-3371	C.8.d	Uhl Pipeline Lat D to TO 24	Replace 2,560 feet of 36" to 30" pipeline	$ 60,000
22-3250	C.3.h	Chadbourne Lateral, end of the line south of I-80	Design only to replace approximately 1,465 feet of 18" to 42" pipe	$ 125,000
23-3323	C.81.e	Pierce Pipeline from TO 6 to TO 10	Replace 2,020 of 30" and 18" pipe.	$ 657,800
23-3322	C.136.b	Weyand Lateral 4, Headworks north of Midway to RR	Replace 3,870 feet of 30" and 36" pipe.	$ 125,000
23-3372	C.131	Kilkenny Lateral K-7	Replace culvert across Weber Road at Fox Road and construct a new check/pump structure	$ 415,800
23-3374	N/A	NRCS Grant Planning	Prepare documents necessary to obtain up to $25M in grant funding for replacement of Ag pipelines	$ 75,000
24-3441	C.140	Lambert Lateral E from Loney Pump to End	Replace 2,690 feet of 10" pipe	$ 573,100
24-3442	C.142	Lateral K-2-B from Minatta Drain to End	Replace 1,250 feet of 12" pipe.	$ 494,400
24-3443	C.98.a	Chadbourne Lateral A from TO 4 to TOs 7&8	Replace 1,890 feet of 18" pipe.	$ 531,900
24-3444	C.141	Lateral 42-2 from Headworks to TO 1	Replace 1,415 feet of 12" pipe.	$ 399,900
TBD	N/A	USDA Grant Management (See note 3)	Prepare documents necessary to obtain up to $15M in grant funding for Ag conservation projects	$ 1,745,844
Work Order	**R&B No.**	**Automation & Modernization Projects**	**Project Description**	**2025 R&B Budget**
24-3446	H.08.d.3	Byrnes Headworks SlipMeter	Install slip meter in existing structure near the Bynes Headworks	$ 92,900
24-3446	H.06.j	Improve Automation at Dally Main Hdwks/Dally D-4	Install additiona motor operated valve or other flow control device to accurately control flow split	$ 75,000
TBD	V.14	Green Valley Conduit Screen Cleaner	Repair and update screen cleaner	$ 175,000
TBD	V.07	Weyand Headworks Screen Cleaner	Install new automated screen and screen cleaner	$ 75,000
TBD	V.14	Dally Highline Pipeline Headworks Screen Cleaner	Install new automated screen and screen cleaner	$ 75,000
Work Order	**R&B No.**	**Facility Projects**	**Project Description**	**2025 R&B Budget**
20-2965	U.29	Asset Management/GIS/CMMS	Finalize the Asset Management Plan	$ 65,000
20-2991	A.3.a	No Trespassing Signage (Canals)	Install signs along various canals in the District	$ 180,000
20-3069	N.7.1	Replace Deepwell (DW)-20 (See note 1)	Replace failing well	$ 500,000
21-3197	N.10	Fence for Well Site in Canal 3 Right-of-way	Fence future well site	$ 48,400
TBD	G.1.b	Bascherini Reservoir Modifications Study	Evaluate and design for long term maintenance of the Bascherini Reservoir to meet both M&I and Ag demands.	$ 80,000
23-3302	N/A	Suisun Valley Feasibility Study	Planning effort to support County's goal of increasing ag tourism	$ 60,266
23-3376	I.19	Olsen Drain Recovery Planning	Install recovery pump at Olsen Drain	$ 150,000
23-3377	U.21	Fox Road Dam Replacment	Replace Fox Road Dam	$ 80,000
23-3378	N/A	Participation in County Collection of LiDAR data (3DHP)	Reimbursement to County for 3D mapping	$ 14,350
24-3379	N/A	FERC Relicensing (See note 2)	FERC Relicensing	$ 50,000
24-3445	N/A	Sawtelle Drain Culvet at Hawkins Road	Replace 100 feet of twin 36" CMP drains and install SlipMeter to measure flow to Main Prairie	$ 606,000
Work Order	**R&B No.**	**Recurring Projects**	**Project Description**	**2025 R&B Budget**
21-3185	F.46	Rubicon Hardware Replacement		$ 50,000
21-3186	D.2.7	Meter Replacement		$ 100,000
21-3187	M	Pump & Motor Rehabilitation/Replacement		$ 150,000
21-3189	H.5.2	Spill Sites & SCADA Rehab/Upgrade		$ 75,000
21-3190	V	Steel Trash & Safety Barriers		$ 50,000
21-3191	V.a	Personnel Safety Handrails, Ladders, & Platforms		$ 40,000
21-3192	U.22	Right-of-Way Correction		$ 50,000
21-3193	U.40	R&B Study		$ 120,000
21-3194	K	Deepwell Inspection and Repair		$ 100,000
21-3195	R	Gate Maintenance and Replacement		$ 100,000
23-3370	W	SID Share of County Aerial Mapping		$ 14,350
24-3447	U.39.a	GIS Updates		$ 300,000
		Total Expenditure:		**$ 9,850,710**
		Beginning Balance R&B Reserves based on December 17, 2024 Treasurer's Report (thru Nov 30):		$ 9,095,420
		December 20th Assessment:		$ 2,000,000
		April 30th Assessment:		$ 1,900,000
		June 30th Assessment:		$ 200,000
		Water Supply Augmentation:		$ 500,000
		USDA Grant Reimbursement:		$ 1,745,844
		Projected End of Year R&B Reserves:		$ 5,590,554

Certificate of Participation (COP)

- Similar to bond funding
- 2021 with infusion of $11M via COP funds set out to replace as much pipe as possible in 3-year deadline
- All construction must occur between outside irrigation season: October 15 and March 15
- Pipe diameters range from 12” to 48”

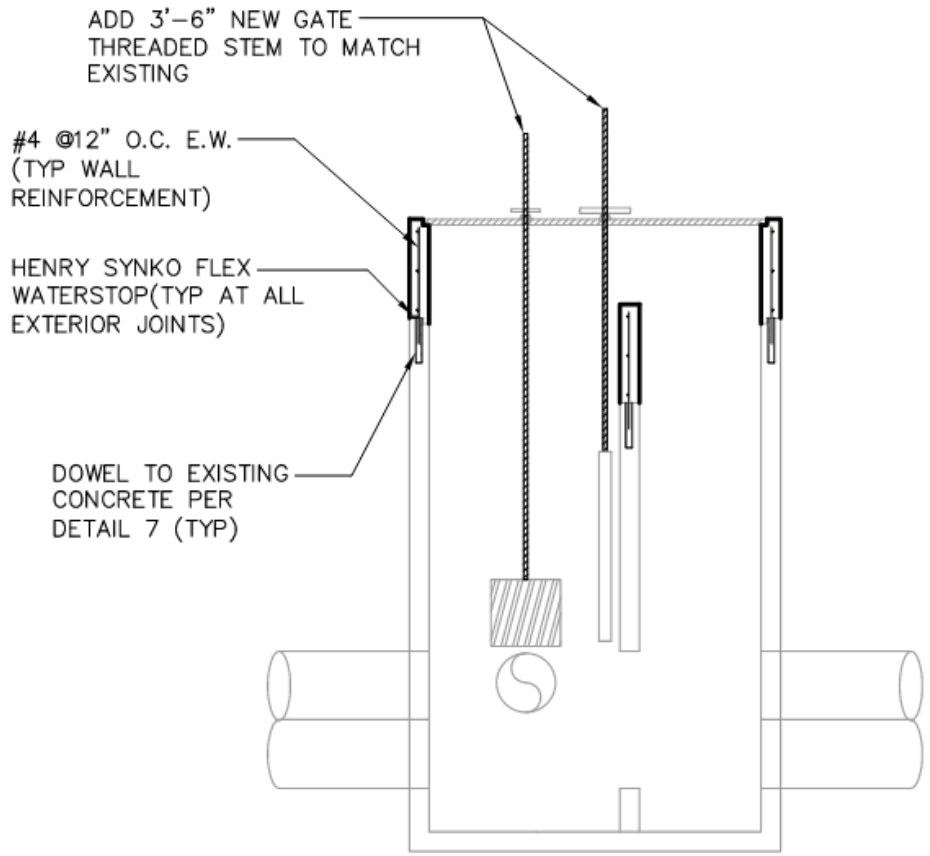
Pipe Replacement by Year



Total Cost for All Projects Shown: $16.6M

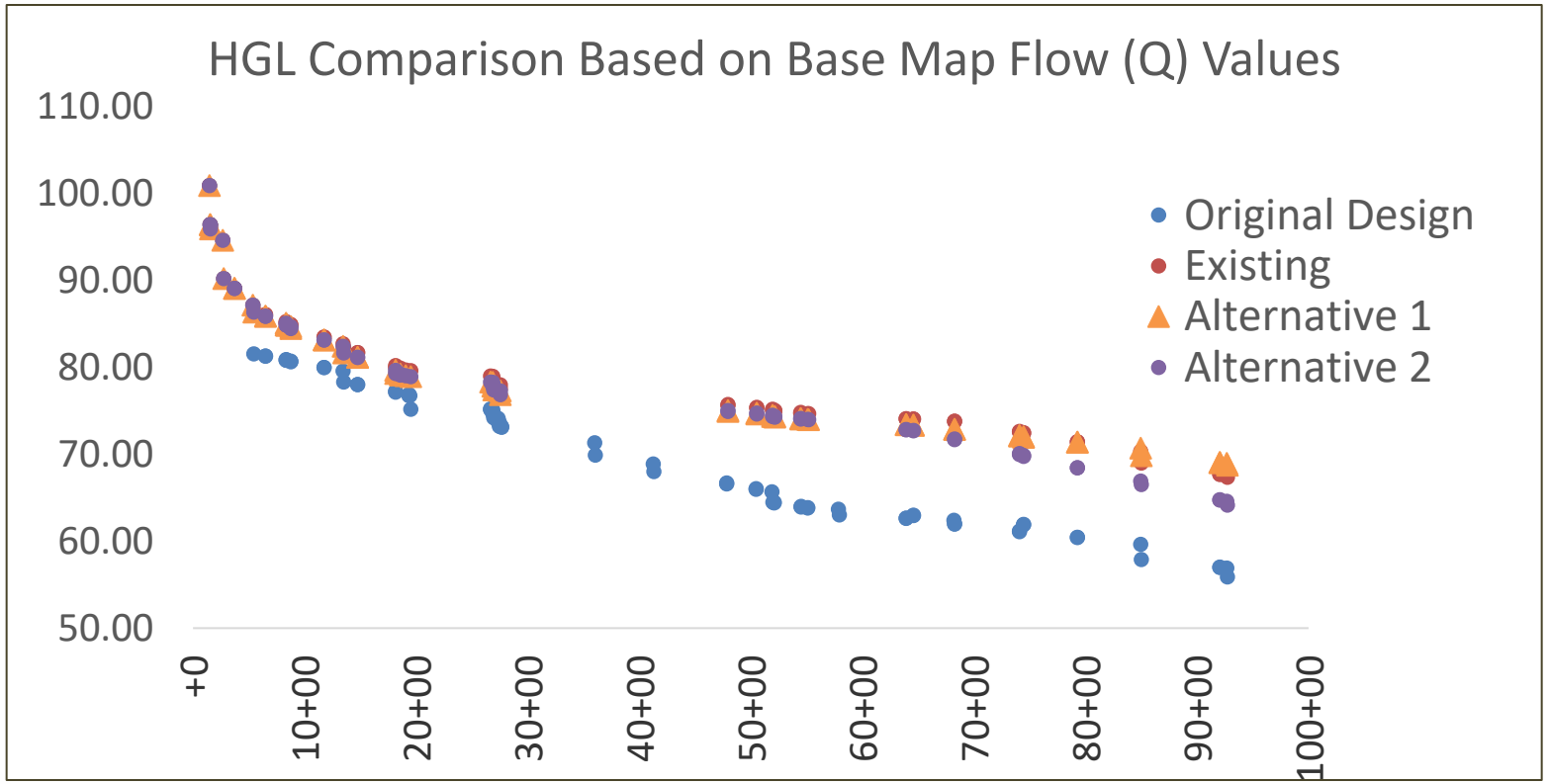
Design Criteria Unique to Agricultural Water Distribution

- Demand is determined by customers not nature
- Constructability is impacted by crop type and specific farming practices
- Historically flow measured based on height over weirs



Hydraulic Modeling Ag System

- Conversion from flood to drip and sprinklers use less water
- Discreet transitions to a closed system challenging
- HGL must be carefully evaluated to prevent overtopping of downstream open structures



Trust but Verify

- Operations & Engineering worked together to establish a known flow rate at locations where the pressure could be measured by a gauge
- The field data corroborated the calculated HGL

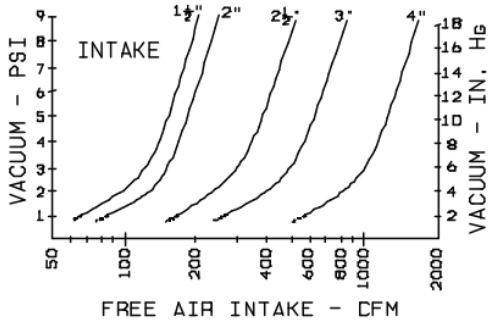
Air and Vacuum Valves

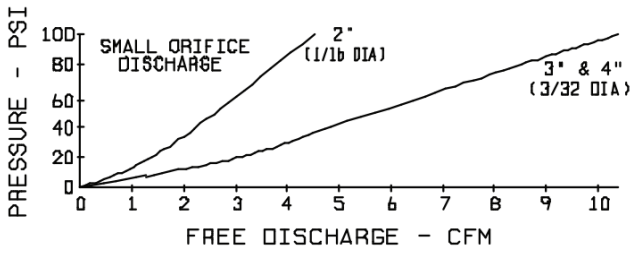
- Start up and shut down procedures
- Air and vacuum Valves for low head systems

Waterman

← AV-150

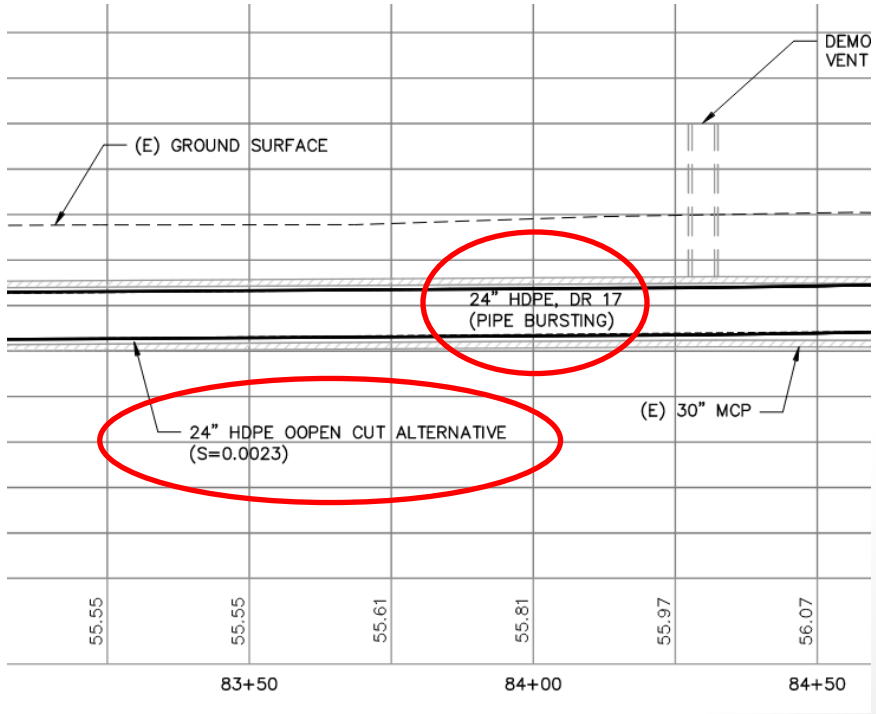
CR-101 →





Slip-lining vs Pipe-bursting

- Existing monolithic concrete, unsure of roundness
- Specification written for pipe-bursting with “where host pipe remains intact, cellular grout annular space”
- Contractor option for open cut or pipe bursting
- Where existing pipe was found to be deep enough allowed pipe-bursting
- Several hundred feet of slip-lining but no actual bursting occurred

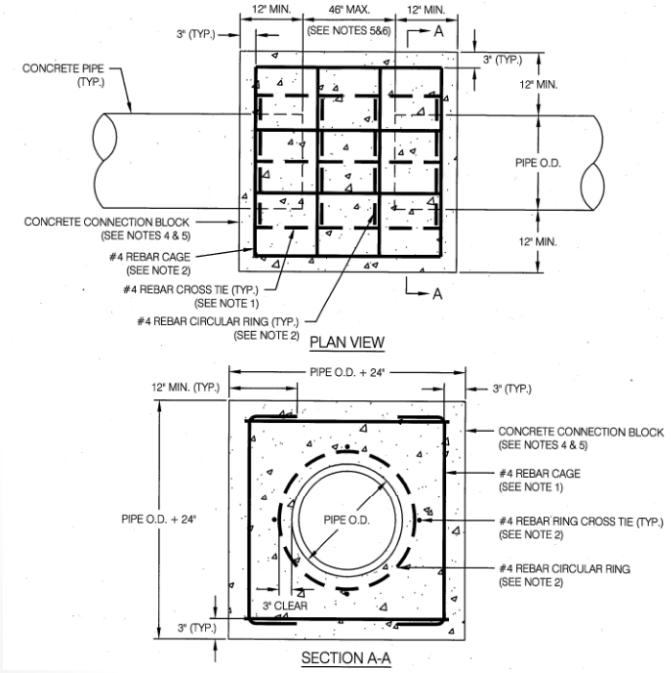


HDPE Beyond Pressure Rating

- Ag lines all low pressure (<25 psi) unless pumped
- In-house construction backfill with dumped sand or native (mostly clay); heavier wall allows for lower E’
- More resistant to farming activities
- District standardized on DR17 IPS

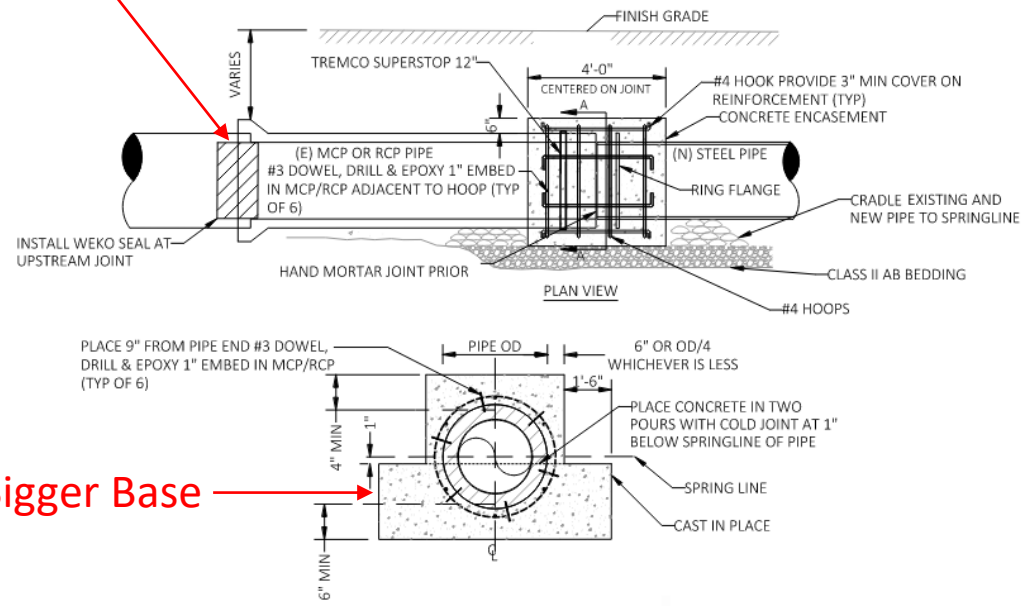
Connections: HDPE to MCP

- End HDPE with a flange & connect to flanged steel, then connect to concrete pipe
- In-house seal with mortar and epoxy only



DISTRICT STD DRAWING

Weko Seals

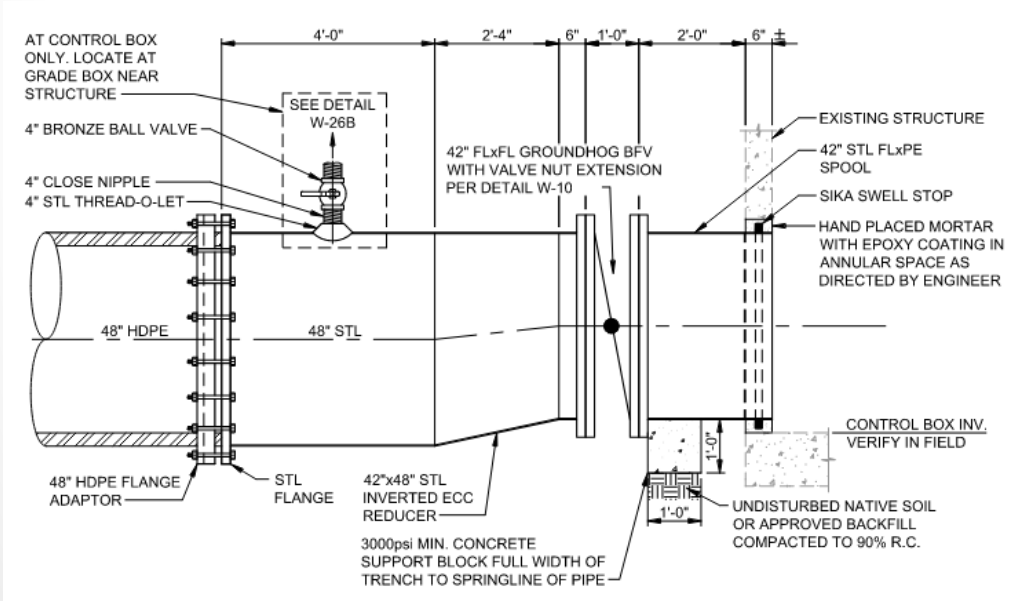


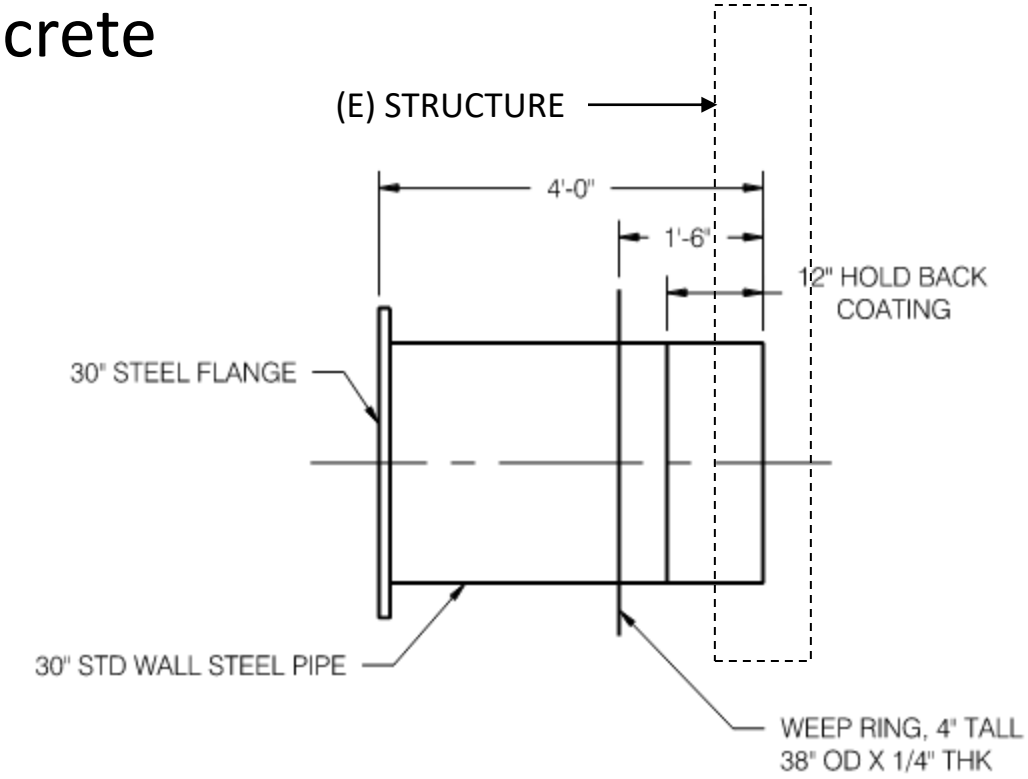
Bigger Base

3RD ITERATION OF DESIGN DRAWING

Connections to Structures

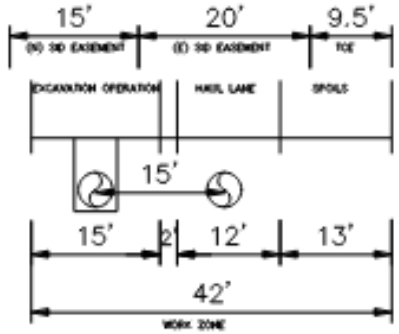
- End HDPE with a flange & connect to flanged steel, then connect steel to concrete structure
- Embed weep ring on steel in concrete

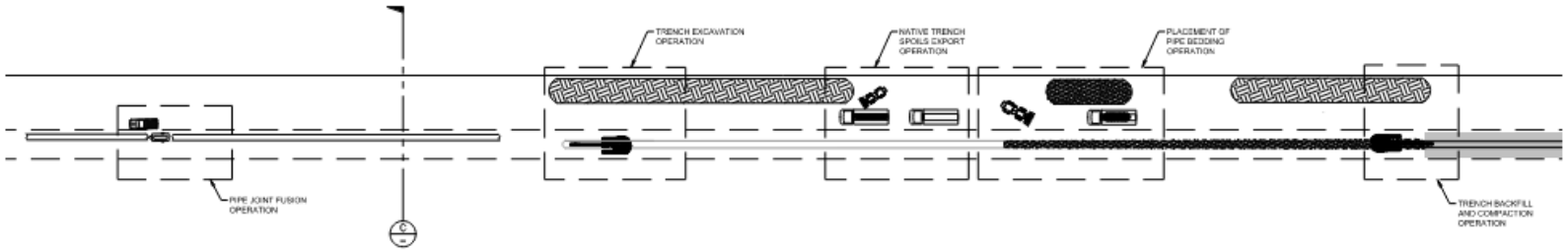




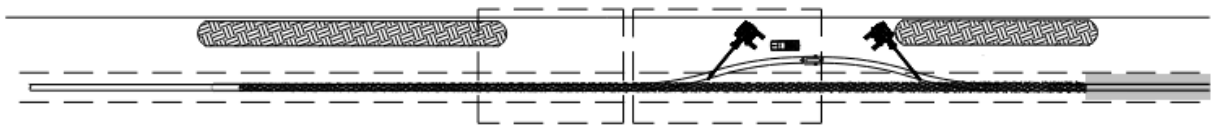
Cost Value Analysis of TCE

- Constrained working conditions have a significant impact on project cost.





CASE 3
PARALLEL INSTALLATION
IMPEDENCE=MODERATE
STAGE 1

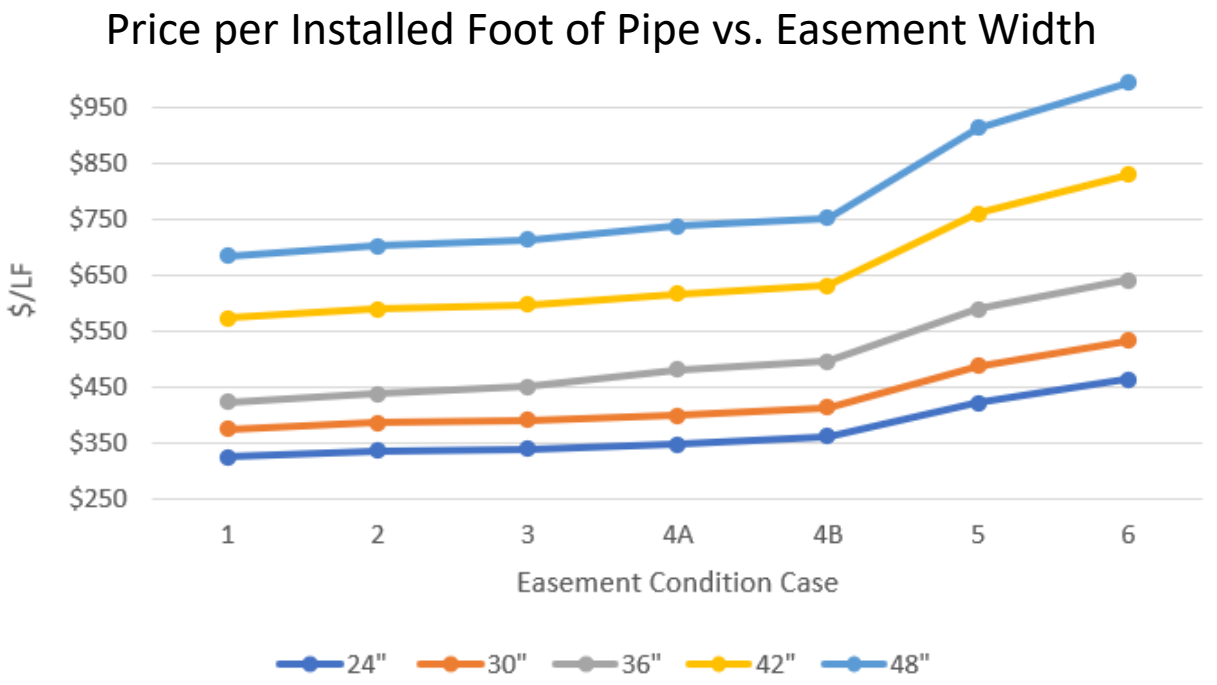


CASE 3
PARALLEL INSTALLATION
IMPEDENCE=MODERATE
STAGE 2

Cost Value Analysis of TCE

Pipe OD (inches)	Construction Case [1]						
	1	2	3	4A [2]	4B [2]	5 [3]	6 [4]
	NONE ←			IMPEDENCE			→ HIGH
24	58	46	39	27	35	35	20
	15	15	15	0	15	15	0
	23	21	6	0	0	0	0
	$325	$337	$340	$347	$362	$422	$463
	$0	$11	$15	$22	$37	$97	$138
	1.00	1.03	1.04	1.07	1.11	1.30	1.42
30	60	48	40	28	35	35	20
	15	15	15	0	15	15	0
	25	23	8	0	0	0	0
	$375	$387	$391	$400	$415	$488	$533
	$0	$12	$16	$25	$40	$113	$158
	1.00	1.03	1.04	1.07	1.11	1.30	1.42
36	61	49	41	29	29	35	20
	15	15	15	0	15	15	0
	26	24	9	0	0	0	0
	$423	$438	$451	$482	$497	$589	$641
	$0	$15	$27	$58	$73	$166	$218
	1.00	1.03	1.06	1.14	1.17	1.39	1.51
42	63	51	42	30	30	35	20
	15	15	15	0	15	15	0
	28	25	10	0	0	0	0
	$573	$590	$598	$617	$632	$761	$829
	$0	$17	$25	$44	$59	$188	$256
	1.00	1.03	1.04	1.08	1.10	1.33	1.45
48	65	53	44	32	35	35	20
	15	15	15	0	15	15	0
	30	26	11	0	0	0	0
	$684	$703	$714	$737	$752	$914	$995
	$0	$19	$30	$53	$68	$230	$311
	1.00	1.03	1.04	1.08	1.10	1.34	1.45

- Temporary Construction Easements have an initial cost but frequently can reduce overall project costs

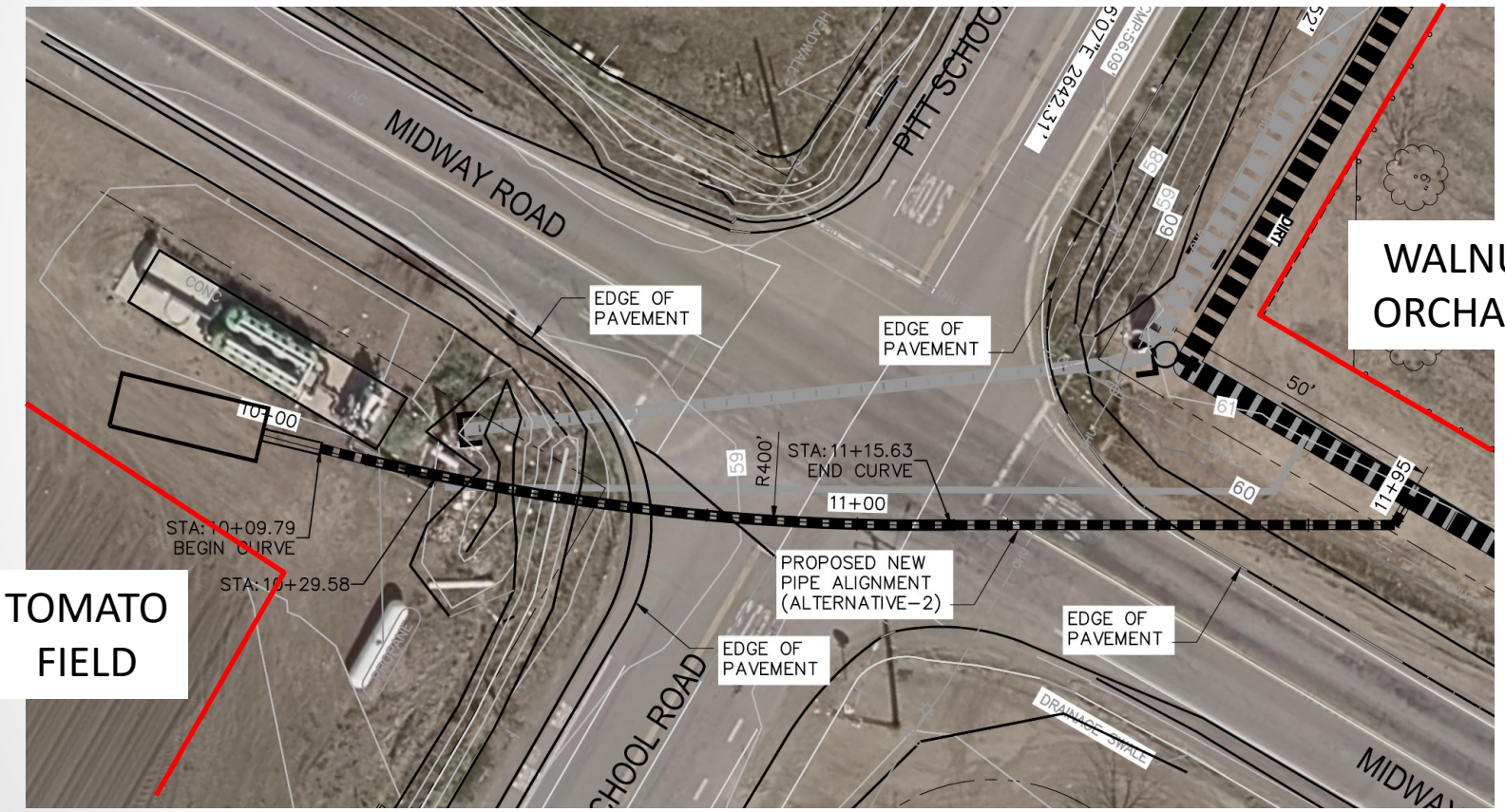


Constrained Construction Space

- Construction space constrained primarily by farming activities
  - No vehicles within 10 feet of tree trunk
  - No vehicles over drip tape
  - Silt fencing required to protect horse training arena

- Coordination with PG&E
  - Underground service, contractor chose to work 48” pipe around service rather than engage PG&E
  - Installed 48” pipe between power pole and guy wire

HDD from Walnuts to Tomatoes



Constrained Schedule

- No work during irrigation season
  - Generally, March 15 to October 15, but set by the Board 1 month prior
  - Some walnuts have particularly late harvest, so no work before November 15
  - Leaves 4-5 winter months for construction
- Two Notices to Proceed
  - Phase 1 – Preliminary Operations
    - Submittals
    - Permits
    - Procurement
    - Prep staging area
    - No demolition
    - Avoid heavy equipment over existing pipes
  - Phase 2 - Construction

Contractor Notice & Prequalification

NOTICE TO CONTRACTORS

The Solano Irrigation District (SID) will be soliciting bids for the Upper Weyand Pipeline Replacement Project. Contractors must be prequalified prior to bidding on this project. Contract Documents available for purchase at www.sidwaterbids.com and for viewing at District office. Prequalification information is available website at https://www.sidwaterbid.com.org/bids.aspx

ANTICIPATED SCHEDULE (all dates subject to change without notice):

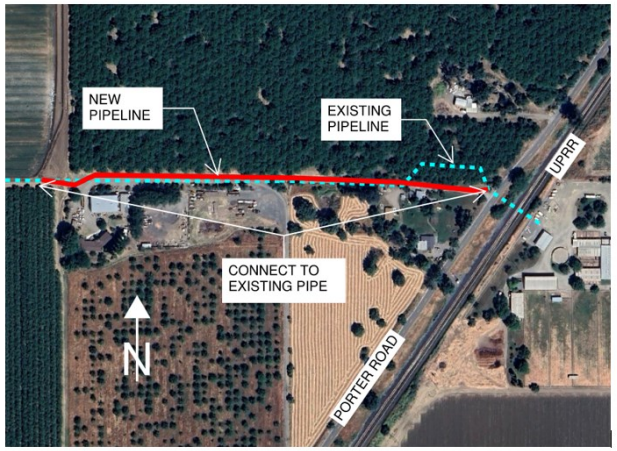
- Bid Documents available: August 16, 2023
- Bid Opening: Thursday October 5, 2023
- Contract Award: Tuesday July 19, 2022
- Project Completion: February 2023

All work must be complete prior to the start of irrigation season (March 1, 2024).

PROJECT LOCATION:
The project is located adjacent and through rural driveways and orchards approximately ½ mile north of Midway Road from ½ mile east of Batavia Road to Porter Road, near Dixon in Solano County California.

PROJECT DESCRIPTION:
The project includes replacing approximately 1,660 feet of 48, 34 and 36-inch monolithic concrete pipe with 48-inch diameter DR 17 HDPE pipe. Portions of the alignment include removing monolithic concrete pipe and replacing it with HDPE, installing HDPE in parallel trenches.

Major pipeline work and rough work limits shown on the following figure. Several items of work omitted for clarity.



- Notice to all contractors we were aware of
- During first bid, questions from small firms, added qualifications to spec
- Future projects pre-qualified contractors using state template and scoring below
  - *28- thru 30-inch diameter HDPE:*
    1 point for each 1,000 feet installed.
  - *32- thru 36-inch diameter HPDE:*
    2 points for each 1,000 feet installed.
  - *42-inch diameter HPDE:*
    4 points for each 1,000 feet installed
  - *48-inch HPDE:*
    6 points for each 1,000 feet
  - **Minimum 10 points to pass**

Prepurchase Materials

- First Project:
  - Originally designed for in-house construction
  - Pre-purchased ALL materials: pipe, fittings, nuts, bolts, gaskets, etc.
  - Fabricated all steel fittings and manifolds in-house
- Second – Fourth Project:
  - Pre-purchased pipe, fittings and valves larger than 12”
  - Split steel fabrications in-house and outside pipe fabricator

- Need to be very clear on what is provided and what is not
- Include cut sheets for pre-purchased material in specs
- Increased construction contingency to 15%

Prepurchase Materials

- Delivery is an issue because pipe must be stored near job or will require additional move
- Traffic control, equipment & scheduling on the District
- Beveled and Non-beveled HDPE flanges different lengths

- Segmented vs single piece gasket

- The case of the missing electrofusion branch

Constrained Alignment

500 feet of 48” pipe in 18’ corridor

Turning the Corner

Slip-Lining

Written as pipe-burst so contractor mandrilled before pulling new pipe

Slip-lined 350-500 feet a day with separate crew fusing ahead.

Cellcrete used to fill annular space

Old Rehabilitation Failed

Slip-lined through Techite where possible

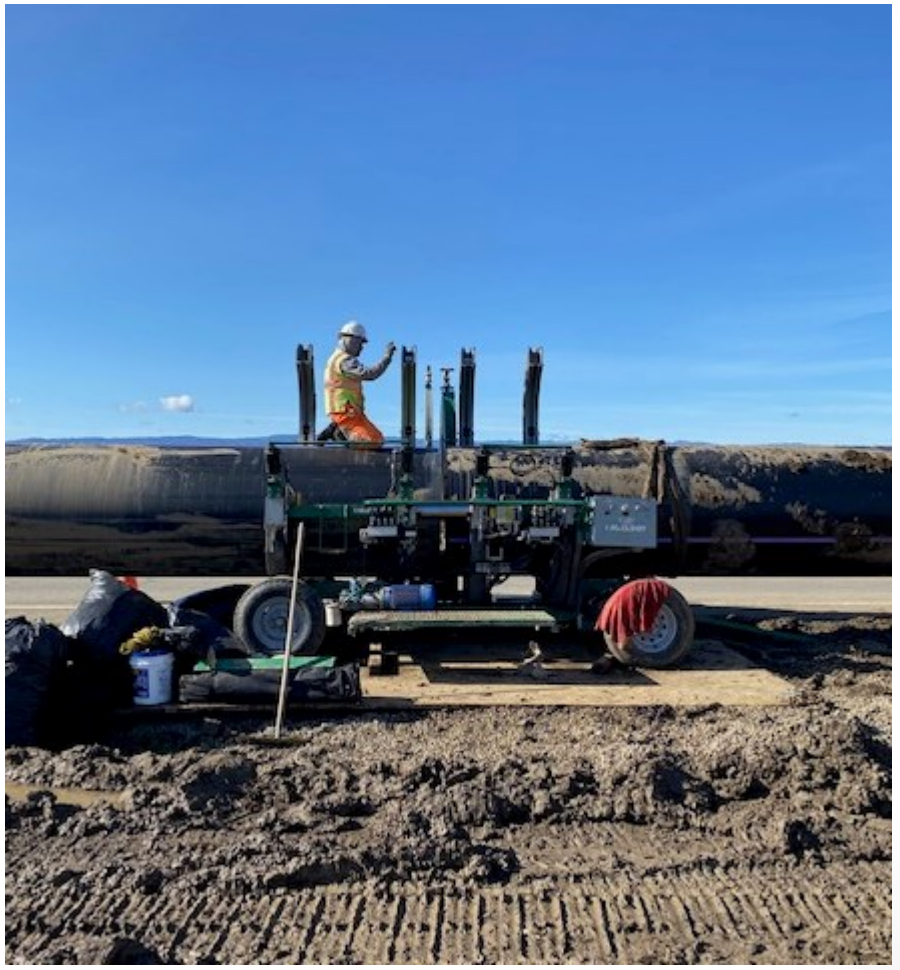
Techite removal is messy

Pipe Does Float

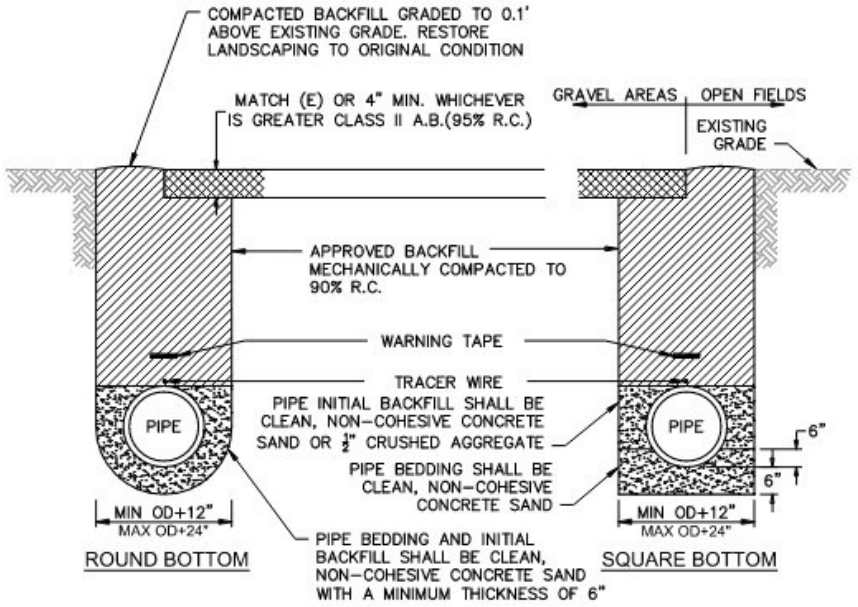
Reuse/Repurpose

Fusion of Large Diameter HDPE

- Handling 50’ long 48” diameter pipe is challenging
- Staging must be considered when fusing ahead of installation
- Large fusion machines are expensive
- Fusion subcontracted on all but one contractor projects and all in-house projects



Round Bottom Bucket



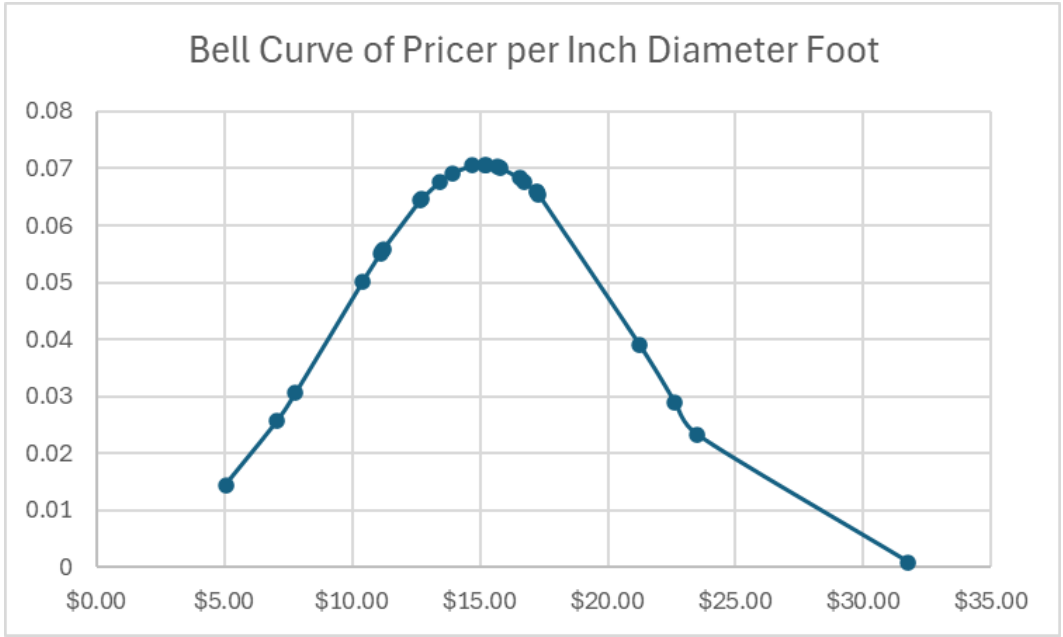
- Round bottom buckets
  - Minimize spoils
  - Minimize bedding
  - Can reduce shoring
- Thus far there has been only once contractor that opted for this methodology

SUIEXC5048RBB - 48" ROUND BOTTOM BUCKET TO FIT 326F WITH PINS WITH CAT STYLE TEETH	18700.00

Costs

- Overall costs including design, construction & inspection
- In-house Construction is also in-house design
- Highest costs mostly related to shorter projects ~<500 feet
- One high-cost project was large diameter, less than 2,000 ft but very constrained access and work area
- Lowest costs related to smaller diameter in unconstrained fields

$/in-dia-ft	Overall	Eliminating High and Low	Contractor	In-House
Max	$31.75	$23.50	$22.61	$23.50
Average	$15.09	$14.80	$18.55	$14.62
Min	$5.05	$7.06	$15.18	$7.06



Change Order Range: 1.4% to 8.5%
Average: 3.74%

Lessons Learned

- Involving Operations Staff in design ensures operability
  - Changed valve locations so that water could flow upstream or downstream
  - Only replaced necessary turnouts with properly sized pipe and meters
- Prequalification was worth it
- The amount of working space does affect cost
- Double notice to proceed worked well
- HDD works well for us, but we need to make sure there is adequate space
- Owner supplied materials: focus on the large diameter pieces
- HDPE fittings: understand pressure derating; add 1 foot to each end of fitting
- HDPE thermal expansion & contraction: add weep rings to steel at structures, add wall anchors along alignment
- Protect pipe from floating
- Electrofusion requires careful installation; we avoid as much as possible