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TECHNICAL MEMORANDUM

DATE:	September 27, 2021	Project No.: 941-80-12-59 SENT VIA: EMAIL
TO:	Justin Nakano, Water Resources Technical Manager, Chino Basin Watermaster	
CC:	Andy Campbell, Groundwater Recharge Coordinator, Inland Empire Utilities Agency	
FROM:	Carolina Sanchez, PE; Mary Young, PE; Garrett Rapp, PE	
REVIEWED BY:	Andy Malone, PG	
SUBJECT:	Chino Basin Watermaster Other Recharge Improvement Projects Study	

INTRODUCTION

As part of its fiscal year (FY) 2020/2021 budget, the Chino Basin Watermaster (Watermaster) included engineering feasibility studies for potential improvements at three recharge basins to ensure that the 2013 Recharge Master Plan (RMPU) implementation projects will operate as intended. Inland Empire Utility Agency (IEUA) operates the three recharge basins: Etiwanda, San Sevaine, and Jurupa Basins.

West Yost and staff from Watermaster and IEUA agreed to conduct the initial feasibility study for the Jurupa Basin, with feasibility studies for the other basins to follow. Potential improvements to be studied for the Jurupa Basin include re-armoring or re-constructing the conservation berm within the recharge basin and installing a trash collection system at the existing pump station intake.

This Technical Memorandum (TM) presents the results of the study for the Jurupa Basin which includes the following:

- Documentation of Existing Conditions
- Conservation Berm Improvement Alternatives
- Trash Collection System Improvement Alternatives
- Conclusions and Recommendations
- Next Steps

DOCUMENTATION OF EXISTING CONDITIONS

West Yost collected and reviewed record drawings for the Basin and conducted a site visit to document existing conditions at the Jurupa Basin. The results are described below.

Record Drawing Review

West Yost reviewed record drawings provided by IEUA. As-built drawings for the pump station intake prepared by Tetterner & Associates dated 2002 provided dimensions and elevations for the intake structure and were used for the preliminary design of the trash collections improvements. An aerial topographic survey of the Jurupa Basin prepared by AeroTech on September 8, 2015 (AeroTech Topo) was provided in AutoCAD. As-built drawings for the intake structure and the aerial survey are included in Appendix A. The aerial survey was used to prepare the figures showing the trash collection and berm improvements. The as-built drawings and the aerial survey appear to be based on different elevation datums. The as-built drawings state that elevations are based on a local benchmark, and the aerial survey does not reference its elevation datum. Elevations on the as-built drawings appear to be about 2.6 feet lower compared to the aerial survey elevations. For this study, the elevations from the as-built drawings were adjusted upward by 2.6 feet to be consistent with the aerial survey elevations.

Site Visit

West Yost toured the Jurupa Basin on March 17, 2021 with Andy Campbell of IEUA to photograph and document existing conditions.

Conservation Berm

Visual observation of the conservation berm showed there was no significant erosion along the berm except around the weir. The weir area of the conservation berm is armored with concreted rock rip rap. A 42-inch reinforced concrete pipe extends through the weir. There is a headwall with a slide gate on the upstream side of the pipe. The erosion damage is located at the edge of the concreted rock rip rap and extends from about the centerline of the berm to the toe of the west side of the berm. Erosion at the weir is shown in Photo 1. The berm beyond the weir appears in good condition as shown in Photo 2. Berm side slopes are armored with rip rap and large pieces of concrete rubble. Side slopes on the east (water) side of the berm by the basin inflow structure are in good condition as are the side slopes on the west (land) side as shown in Photos 3 and 4. The gravel surface of the roadway on the berm to the south of the weir has washed out as shown in Photo 5; however, the adjacent slopes are in good condition.

Photo 1
Description Erosion along the Edges of Weir

Photo 2
Conservation Berm to the North of the Weir

Photo 3
Rock Slope Protection on Conservation Berm East (Water) Side Slope at Inflow Structure

Photo 4
Rock Slope Protection on West (Land) Side Conservation Berm Side Slope

Photo 5
Gravel Surface on Conservation Berm to the South of the Weir

Pump Station Intake

The pump station intake channel is shown in Photo 6 and the intake structure is shown in Photo 7. The intake channel and structure are in good condition. Floating trash was observed in the channel upstream of the intake and at the intake structure.

Photo 6
Pump Station Intake Channel

Photo 7
Pump Station Intake Structure

Jurupa Basin Operation

The San Bernardino County Flood Control District (SBCFCD) owns the Jurupa Basin. Through an agreement with the SBCFCD, the IEUA operates the Jurupa Basin as a multipurpose basin, meaning that it is primarily operated for flood peak discharge attenuation and secondarily for the recharge of storm and supplemental water.[1] The Jurupa Basin is a flow-by basin. Water can be diverted into the basin from the San Sevaine Channel via the diversion inlet shown in Photo 3. There is a gate to control the diversion into the inlet. Water in storage in the Jurupa Basin can be conveyed to the RP3 Basin via a pump station, the intake channel and structure for which are shown in Photos 6 and 7, respectively. The procedure to capture stormwater in the Jurupa Basin is as follows:

1. The IEUA Operator will close the manual outlet gate (shown in Photo 1) on the Jurupa Basin conservation berm.
2. If there is flow passing the diversion gate from the San Sevaine Channel that has sufficiently low turbidity and debris load, the IEUA Operator will open the diversion gate and divert water into the Jurupa Basin. The diversion gate is then automated to maintain a specific water depth in the Jurupa Basin, no greater than the depth of the conservation berm.
3. After about 24 hours, the IEUA Operator will pump water in storage in the Jurupa Basin to RP3 Basin. Generally, the IEUA Operator allows water to settle in the Jurupa Basin for 24 hours or more to avoid pumping sediment with the stormwater into the RP3 Basin.

If a significant storm is forecast,[2] the IEUA Operator may open the manual outlet gate at the conservation berm if conditions permit. More detail on the operations of the Jurupa Basin can be found in the April 2019 *Chino Basin Recharge Facilities Operation Procedures* Manual.

Baseline Hydrologic Conditions

In addition to understanding and documenting the design and existing conditions of the infrastructure in the Jurupa Basin, West Yost established baseline hydrologic statistics for the Jurupa Basin using Watermaster's R4 surface water model.[3] The R4 model estimates runoff from daily precipitation, routes the runoff through the Chino Basin drainage systems (including recharge basins), and calculates flow and recharge at points along the system. The R4 model was recently updated as part of the 2020 Chino Valley Model (CVM) that was used to recalculate the Safe Yield of the Chino Basin (WEI, 2020). The historical hydrology that the R4 model uses for simulating runoff covers the period from FY 1950 through 2018 and runs on a daily time step.

The R4 model represents the Jurupa Basin based on the AeroTech Topo and as-built engineering drawings. This representation is consistent with the most recent simulations to refine recharge benefit estimates of chosen capital improvement projects identified in the 2013 Update to the 2010 Recharge Master Plan Update (2013 RMPU) (WEI, 2016). The assumptions for the operations of the Jurupa Basin in the R4 model are based on discussions with Andy Campbell at IEUA.

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[1] *Chino Basin Recharge Facilities Operation Procedures*, Groundwater Recharge Coordination Committee, April 2019.

[2] The *Chino Basin Recharge Facilities Operation Procedures* Manual defines a significant storm as "having intensities of more than 0.5 inches per hour or totaling more than 1.5 inches per 24 hours."

[3] Documentation for the R4 Model is included as Appendix A in the report entitled: "2007 CBWM Model Documentation and Evaluation of the Peace II Project Description (WEI, 2007).

West Yost simulated the baseline hydrologic condition in the Jurupa Basin by assuming that no stormwater would be pumped to or from the Jurupa Basin. The height of the conservation berm in the Jurupa Basin is about eight feet, corresponding to a storage capacity of about 240 acre-feet. Any water in the Jurupa Basin above the berm is assumed to overtop the berm and flow out of the basin through the outlets in the southwest corner of the Basin. Currently, the IEUA operates the Jurupa Basin such that water does not reach the top of the berm due to the existing structural deficiencies of the berm.

Under the assumptions outlined above, West Yost simulated the inflows to the Jurupa Basin using the historical daily hydrology from FY1950 through FY2018. Figure 1 shows a probability of exceedance plot of the maximum annual water level in the Jurupa Basin compared to the berm height of eight feet. Based on the historical hydrology, the annual probability of exceedance of the water level exceeding the berm height is about 57 percent, meaning that the modeled water level exceeds the berm height in 57 percent of the simulated years. The inverse of the annual probability of exceedance is the return period, which is the average number of years between years when the water level exceeds the top of the conservation berm. An annual probability of exceedance of 57 percent corresponds to a return period of less than two years. This return period is used as a basis for assuming bi-annual maintenance (i.e., occurring every other year) for the existing conservation berm.

CONSERVATION BERM IMPROVEMENT ALTERNATIVES

Berm Reconstruction Alternatives

As noted in the documentation of existing conditions, damage to the existing berm is limited to the area of the weir, therefore reconstruction alternatives are also limited to the weir area. Most of the damage is at or beyond the edges of the existing concreted rip rap. Figure 2 includes a profile of the existing weir area based on the aerial topographic survey. As shown in the profile, the existing grouted rip rap at the weir ends where the weir is about one foot above the low point of the weir. According to observations by maintenance staff, the water level is generally at least about one-foot deep when flowing over the weir. To better protect the weir area, West Yost proposed that all reconstruction alternatives extend the revetment along the weir to a location that is two vertical feet above the low point of the weir.

West Yost evaluated three alternatives for berm reconstruction and compared those alternatives to maintaining the existing berm, described as the Bi-annual Maintenance Project, and to a true No-Project alternative where no repairs are done to the berm. Alternatives include:

- Alternative 1 Rip Rap – Removing the existing concreted rock rip rap and constructing an expanded area of new concreted rock rip rap revetment
- Alternative 2 Concrete – Removing the existing concreted rock rip rap and constructing an expanded area of reinforced concrete revetment
- Alternative 3 Rebuild – Removing and replacing the entire berm and protecting the new berm with an expanded area of new concrete rock rip rap revetment
- Alternative 4 Bi-annual Maintenance – Constructing no capital improvements and performing maintenance as described in the Operations and Maintenance (O&M) section below
- Alternative 5 No-Project – Constructing no capital improvements and performing no maintenance

Figures 3-5 show the improvements constructed with Alternatives 1 through 3.

Estimated Construction Cost of Berm Alternatives 1 through 3

The preliminary estimated construction costs for Alternatives 1 through 3 are shown in Tables 1 through 3, respectively. In all cost estimates in this TM, percentages for mobilization, construction contingency, construction management, engineering and administration are consistent with those provided by IEUA and used in the 2013 RMPU. Estimating contingency is based upon the conceptual level of design.

Table 1. Estimated Capital Cost Alternative 1 Rip Rap

Item	Description	Quantity	Unit	Unit Cost	Total, dollars
1	Mobilization			5%	7,798
2	Remove existing rock slope protection from levee west side slope and place on adjacent berm	52	CY	$74	3,848
3	Remove existing concreted rock slope protection from weir section, place on adjacent berm side slopes	67	CY	$80	5,360
4	Scarify and compact top 12-inch on berm top and west side slope	5416	SF	$1	5,416
5	Rock slope protection fabric	5416	SF	$2	10,832
6	New concreted rock riprap 1.3-foot section of Caltrans Backing 2 (D50 weight of 25 lbs, approx. 8-inch diameter) on expanded weir section	261	CY	$500	130,500
7	Estimating contingency, conceptual design at 30%			30%	49,126
	Subtotal Direct Construction Cost (rounded)				**$213,000**
	Construction Contingency < $1 million @ 20%			20%	42,600
	Construction Management < $1 million @ 20%			20%	42,600
	Total Construction Cost (rounded)				**$298,000**
	Engineering and Administration < $1 million @ 20%			20%	59,600
	Total Engineering and Administration (rounded)				**$60,000**
	Total Estimated Project Cost				**$358,000**

Table 2. Estimated Capital Cost Alternative 2 Concrete

Item	Description	Quantity	Unit	Unit Cost	Total, dollars
1	Mobilization			5%	17,251
2	Remove existing rock slope protection from levee west side slope and place on adjacent berm	52	CY	$74	3,848
3	Remove existing concreted rock slope protection from weir section, place on adjacent berm side slopes	50	CY	$80	4,000
4	Scarify and compact top 12-inch on berm top and west side slope	5677	SF	$1	5,677
5	Reinforced Concrete	221	CY	$1,500	331,500
6	Estimating contingency, conceptual design at 30%			30%	108,683
	Subtotal Direct Construction Cost (rounded)				**$471,000**
	Construction Contingency < $1 million @ 20%			20%	94,200
	Construction Management < $1 million @ 20%			20%	94,200
	Total Construction Cost (rounded)				**$659,000**
	Engineering and Administration < $1 million @ 20%			20%	131,800
	Total Engineering and Administration (rounded)				**$132,000**
	Total Estimated Project Cost				**$791,000**

Table 3. Estimated Capital Cost Alternative 3 Rebuild					
Item	Description	Quantity	Unit	Unit Cost	Total, dollars
1	Mobilization			5%	17,985
2	Remove existing rock slope protection from levee west side slope and place on adjacent berm	132	CY	$74	9,768
3	Remove existing concreted rock slope protection from weir section, place on adjacent berm side slopes	67	CY	$80	5,360
4	Rock slope protection fabric	7,344	SF	$2	14,688
5	New concreted rock riprap 1.3' section of Caltrans Backing 2 (D50 weight of 25 lbs, approximately 8-inch diameter) on expanded weir section	354	CY	$500	177,000
6	Excavate Existing Berm Section - Stockpile and Rebuild	1,243		$56	69,608
7	Excavate 3 feet below Berm Section and Recompact	1,063		$50	53,150
8	Demolish Existing Culvert and Headwall	1		$2,000	2,000
9	42-inch RCP Culvert	30		$500	15,000
10	Concrete Headwall	5		$1,600	8,000
11	Restore AB Roadway with 6-inch new AB	10		$213	2,130
12	Salvage and re-install slide gate	1		$3,000	3,000
13	Estimating contingency, conceptual design at 30%			30%	113,307
	Subtotal Direct Construction Cost (rounded)				**$491,000**
	Construction Contingency < $1 million @ 20%			20%	98,200
	Construction Management < $1 million @ 20%			20%	98,200
	Total Construction Cost (rounded)				**$687,000**
	Engineering and Administration < $1 million @ 20%			20%	137,400
	Total Engineering and Administration (rounded)				**$137,000**
	Total Estimated Project Cost				**$824,000**

O&M Costs Berm Alternatives 1 through 5

Estimated maintenance costs will consist of materials and labor costs for repair work. Estimated operations costs include the lost value of the water not recharged in the basin due to the condition of the berm. The Jurupa Basin may have additional operation costs beyond the value of the lost water; however, we have assumed these other operations costs would be identical for all the Alternatives and have not included them in this study.

Costs of Lost Recharge

Storage for recharge was based on the stage/storage calculated using the AeroTech Topo shown in Table 4.

Table 4. Stage/Storage Calculation in the Jurupa Basin				
Stage Elevation, ft-amsl	Wetted Area, Square Feet	Incremental Storage, Cubic Feet	Incremental Storage, Acre-Feet	Cumulative Storage, Acre-Feet
894	0	0	0	0
895	5,289	0	0	0
896	324,302	39,237	0.90	0.90
897	989,514	610,436	13.11	14.01
898	1,450,553	1,824,545	27.87	41.89
899	1,650,936	3,385,151	35.83	77.71
900	1,750,109	5,093,982	39.23	116.94
901	1,811,688	6,877,504	40.94	157.89
902	1,852,319	8,711,575	42.10	199.99
903	1,887,940	10,582,322	42.95	242.94
904	1,930,593	12,491,977	43.84	286.78

It was assumed the maximum water level in the Jurupa Basin is the low point of the weir (elevation 901 based on the AeroTech Topo) when the berm has no damage. In a damaged condition, the water level would be maintained two feet below the weir low point (elevation 899) reducing the volume of stormwater recharge. It is further assumed if maintenance to repair the berm is done, it will occur in the summer after the damage, so that only one year of reduced storage and recharge will result. If the weir fails, the maximum storage elevation would correspond to the elevation at the base of the weir (elevation 895), at which elevation there is no corresponding storage resulting in minimal recharge.

Scenarios simulating the operation of the Jurupa Basin at the two lower water level thresholds were simulated using the R4 model. To estimate the lost recharge, the average annual loss of stormwater recharge was calculated relative to operating the basin at water levels up to the bottom of the weir. All scenarios assume the additional grading and pumping facilities for the 2013 RMPU Project 23a, which is currently under construction, will be operational.

The cost of the lost recharge was estimated to be $799 per acre-foot, which is equivalent to the 2021 cost for Tier 1, full-service untreated water imported from the Metropolitan Water District. Table 5 shows the amount of storage when the basin is operated at different levels due to the condition of the berm, the lost recharge when compared to the assumed maximum operating level, and the cost of the lost recharge.

Table 5. Estimated Cost of Lost Recharge				
Maximum Water-Level Condition	Water Level Elevation, ft-amsl	Storage Volume, acre-feet	Lost Recharge, acre-feet	Cost of Lost Recharge, dollars
Water Level at Weir Crest	901	157.89	0	--
Water Level 2' Below Weir Crest	899	77.71	46	36,754
Water Level with Berm Failure	895	0	318.5	254,481

O&M Costs Alternatives 1 through 5

Alternative 1 maintenance expenditures assume that settlement of the existing earth material would damage the new rip rap surface of the weir resulting in erosion of the earth berm. The settlement may occur because the berm was not fully removed and recompacted prior to constructing the new rip rap surface. It was assumed this damage would occur every 10 years and it would require maintenance to a 10-foot by 10-foot section of the berm. A description of the required maintenance activities is included with the cost estimate in Table 6. Operations costs for Alternative 1 include the lost value of the water that would not be able to recharge in the year the berm experienced damage. It was assumed the water level in the basin would be maintained at a level two feet below the maximum capacity in the years the berm experienced damage (every 10 years).

Table 6. Estimated O&M Costs for Alternative 1

Item	Description	Quantity	Unit	Unit Cost	Total, dollars
1	Mobilization			5%	156
2	Remove existing concreted rock slope protection from weir section, place on adjacent berm	4	CY	$80	320
3	Scarify and compact top 12-inch of berm in damage area	100	SF	$1	100
4	Rock slope protection fabric	100	SF	$2	200
5	New concreted rock rip rap 1.3-foot section of Caltrans Backing 2 (D50 weight of 25 lbs., approximately 8-inch diameter) on expanded weir section	5	CY	$500	2,500
6	Estimating contingency, conceptual design at 30%			30%	983
	Subtotal Direct Construction Cost (rounded)				**$4,000**
	Construction Contingency < $1 million @ 20%			20%	800
	Construction Management < $1 million @ 20%			20%	800
	Total Construction Cost (rounded)				**$6,000**
	Engineering and Administration < $1 million @ 20%			20%	1,200
	Total Engineering and Administration (rounded)				**$1,000**
	Total Estimated Maintenance Cost Every 10 Years				**$7,000**
	Operations Cost - Total Estimated Water Loss Cost Every 10 Years	**46.0**	**AC-FT**	**$799**	**$36,754**
	Total Estimated O&M Cost Every 10 Years (rounded)				**$43,800**

Alternative 2 was assumed to require no maintenance during the 30-year life cycle analysis period. Reinforced concrete structures have a typical lifespan of 50 years. Alternative 2 does not include removal and reconstruction of the existing berm, however, it is assumed the concrete revetment would span any localized settlement of the berm and maintenance would not be required. Keyways constructed along the edges of the concrete would prevent water from flowing under the concrete. Water levels in the recharge basin would be allowed reach the elevation of the weir low point and there would be no lost water storage.

Alternative 3 was also assumed to require no maintenance during the 30-year life cycle analysis period. Alternative 3 includes reconstruction of the entire berm and new concreted rip rap revetment. Water levels in the recharge basin would be allowed reach the elevation of the weir low point and there would be no lost water storage.

Alternative 4 assumes there would not be a capital project to improve the berm. Alternative 4 assumes every two years there would be damage to the berm that would require repair of a 10-foot section of the top and land side of the berm (300 square feet). The two-year frequency is based on the estimated return period of the baseline water level in the Jurupa Basin exceeding the berm height (see section on Baseline Hydrologic Conditions). A description of the required maintenance activities is included with the cost estimate in Table 7. Maintenance repairs would take place bi-annually until the entire 144-foot length of the weir section has been repaired in 10-foot increments. This biannual maintenance would occur throughout the 30-year life cycle analysis period. Every two years water levels in the recharge basin would be held to an elevation that is two feet below the weir low point. O&M costs include the corresponding cost of lost water storage due to this lower water level. This cost is shown in Table 7.

Table 7. Estimated O&M Costs for Alternative 4

Item	Description	Quantity	Unit	Unit Cost	Total, dollars
1	Mobilization			5%	739
2	Remove existing rock slope protection around and below area of repair, place on adjacent berm	12	CY	$74	888
3	Scarify and compact top 12-in of berm in damage area	300	SF	$1	300
4	Rock slope protection fabric	300	SF	$2	600
5	New concreted rock riprap 1.3-ft section of Caltrans Backing 2 (D50 weight of 25 lbs., approx. 8-in diameter) in area of repair	26	CY	$500	13,000
6	Estimating contingency, conceptual design at 30%			30%	4,658
	Subtotal Direct Construction Cost (rounded)				**$20,000**
	Construction Contingency < $1 million @ 20%			20%	4000
	Construction Management < $1 million @ 20%			20%	4000
	Total Construction Cost (rounded)				**$28,000**
	Engineering and Administration < $1 million @ 20%			20%	5,600
	Total Engineering and Administration (rounded)				**$6,000**
	Total Estimated Bi-Annual Maintenance Cost				**$34,000**
	Operations Cost - Total Estimated Bi-Annual Water Loss Cost	**46.0**	**AC-FT**	**$799**	**$36,754**
	Total Estimated Bi-Annual O&M Cost (rounded)				**$70,800**

Alternative 5 assumes there would not be a capital project to improve the berm and there would be no maintenance performed. O&M costs include only the cost of lost water. It was assumed water levels in the recharge basin would be held to an elevation that is two feet below the weir low point for five years and the berm would fail in year six, resulting in no water storage in years six through 30. Operations costs resulting from the lost storage are shown in Table 8.

Table 8. Estimated O&M Costs for Alternative 5

Description	Quantity	Unit	Unit Cost, dollars	Total, dollars
Total Estimated Maintenance Cost				0
Operations Cost - Total Estimated Cost of Lost Recharge, Years 1 through 5	46.0	AC-FT	799	36,754
Operations Cost - Total Estimated Cost of Lost Recharge, Years 6 through 30	318.5	AC-FT	799	254,482

Life Cycle Costs

To enable comparison of the life cycle costs for the alternative projects and the no-project alternative based on net present value (NPV), a life cycle cost analysis was completed. This analysis evaluates estimated O&M costs over the anticipated life cycle of the proposed improvements. Table 9 presents the gross economic analysis parameters assumed in the development of the NPV calculations.

Table 9. NPV Analysis Parameters

Parameter	Assumed Value
Discount Rate	2.6 percent
Inflation Rate Construction Maintenance	2.0 percent
Inflation Rate Cost of Raw Water	4.0 percent
Life Cycle Period	30 years

Using the estimated O&M cost inputs presented in the preceding sections, the estimated life cycle O&M costs for the alternative projects and no-project alternative were calculated. The results of those calculations are summarized in Table 10 below along with the capital cost of the different alternatives.

Table 10. Estimated NPV of Alternatives

Category	Alternative 1, dollars	Alternative 2, dollars	Alternative 3, dollars	Alternative 4, dollars	Alternative 5, dollars
Capital Costs	358,000	791,000	824,000	-	-
NPV of O&M Costs	163,000	0	-	1,148,000	4,688,000
Total NPV	**$521,000**	**$791,000**	**$824,000**	**$1,148,000**	**$4,688,000**

Non-Economic Considerations

In addition to life cycle costs, the alternatives may be evaluated based on non-economic considerations summarized in Table 11 below.

Table 11. Non-Economic Considerations for Improvement Alternatives

Alternative	Advantages	Disadvantages
Alternative 1 Rip Rap	• Simplest construction with least amount of construction time	• Berm material under the existing rip rap may contain obvious void spaces or unsuitable material that will require remediation prior to placing new rip rap, resulting in a construction change order • Concreted rip rap is not a smooth driving surface
Alternative 2 Concrete	• Concrete provides a smooth driving surface • Maintenance should not be required	• Reinforced concrete will increase duration and complexity of construction • Berm material under the existing rip rap may contain obvious void spaces or unsuitable material that will require remediation prior to placing new concrete, resulting in a construction change order
Alternative 3 Rebuild	• Berm is completely rebuilt with competent material • Compaction of material under berm will prevent settlement • Berm can use excavated material from the trash boom access road • All unsuitable material in the weir section will be removed	• Concreted rip rap is not a smooth driving surface • Increased construction time over Alternative 1
Alternative 4 Bi-annual Maintenance	• No capital project • Damage may not occur as projected, lowering required O&M cost	• Concreted rip rap is not a smooth driving surface • Requires regular inspection of berm to locate damage • Requires recurring maintenance • Reduces water recharge in the basin
Alternative 5 No-Project	• No capital project • Damage may not occur as projected, increasing the time the berm will remain in place and operational and lowering required O&M costs	• Reduces and ultimately eliminates water conservation recharge in the basin

TRASH COLLECTION SYSTEM IMPROVEMENT ALTERNATIVES

IEUA is interested in installing a trash collection system at the intake to the pump station. The trash collection system could possibly be paid for with a $25,000 trash removal grant. The grant money was intended for trash removal improvements at multiple locations.

West Yost developed alternatives for improving trash collection at the pump station intake in the Jurupa Basin. Because the area at the top of the pump station intake can be completely submerged during high flow events, mechanical trash rakes were not considered. West Yost reviewed a variety of physical methods to collect the trash.

Trash Collection Alternatives

West Yost reviewed a number a trash booms that would direct floating trash to one side of the low flow channel. We also looked at the Bandalong Litter Trap, which has floating booms along with a lift out trash collection basket. Due to the cost of the Litter Trap, $187,400, it was not considered as an alternative for trash collection. The Litter Trap is shown is Photo 8.

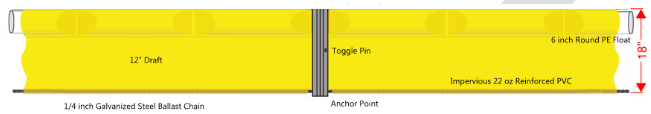
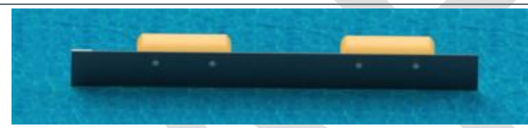
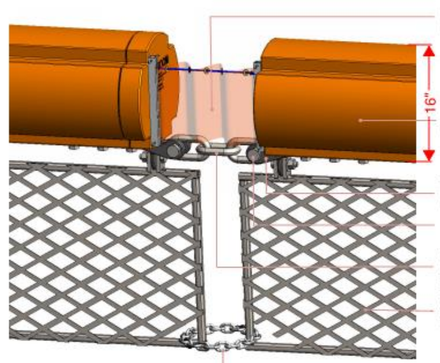
Photo 8
Bandalong Litter Trap

Floating Containment Booms

West Yost compared floating containment booms from a variety of manufactures. The boom would be installed at an angle to the intake. The predominate wind direction in the area is from the west and south so the containment boom is angled to the northwest. The boom layout is shown in Figure 6.

Table 12 presents manufacturer, product photos, cost, and life expectancy information for five different containment booms. The costs shown are for 230 feet of boom and include tax and delivery to the site. Costs do not include installation, as IEUA indicated it would do the installation.

Table 12. Boom Alternatives

Manufacturer	Photo	Cost for 230-feet, dollars	Life Expectancy
GEI Works 18-inch Containment Boom		5,100	3-5 years
ABASCO BETA 1C-SP with UV Inhibitors		5,200	15 years
Bolina Booms		23,200	15 years
Worthington TUFFBOOM		20,900	10-15 years
Worthington TUFFBOOM with Screen		35,700	10-15 years

(a) Vendor price quotes are from May-June 2021
(b) Costs include delivery to the job site and tax but do not include installation

Site Improvements for Trash Collection

To facilitate collection of the trash along the boom a road should be constructed that will access the bottom of the low-flow channel. West Yost placed the road on the west side of the boom so vehicles and trash collection equipment will not need to cross the boom. The access road is shown in Figure 6.

West Yost looked at constructing a gravel road or a concrete access road. The concrete surface is more durable under submerged conditions and fluctuating water levels; however, it is more expensive than constructing a gravel road. The preliminary estimated construction costs for the concrete access road and the gravel access road are shown in Tables 13 and 14, respectively.

Table 13. Estimated Costs for Concrete Access Road

Item	Description	Quantity	Unit	Unit Cost	Total, dollars
1	Mobilization			5%	5,381
2	Dust Control	1	CY	$6000	6,000
3	Dewatering	1	SF	$13,000	13,000
4	Trash Boom Anchor Posts	2	SF	$2,000	4,000
5	Excavate for Roadway and Place Dirt at Recharge Berm	522	CY	$30	15,660
6	Concrete Paving (6-inch concrete section with 6-inch cutoff walls)	41		$1,500	61,500
7	Aggregate Base (compact sub-base place and compact 6-inch of AB)	35		$213	7,455
8	Estimating contingency, conceptual design at 30%			30%	33,899
	Subtotal Direct Construction Cost (rounded)				**$147,000**
	Construction Contingency < $1 million @ 20%			20%	29,400
	Construction Management < $1 million @ 20%			20%	29,400
	Total Construction Cost (rounded)				**$206,000**
	Engineering and Administration < $1 million @ 20%			20%	41,200
	Total Engineering and Administration (rounded)				**$41,000**
	Total Estimated Project Cost				**$247,000**

Table 14. Estimated Costs for Gravel Access Road

Item	Description	Quantity	Unit	Unit Cost	Total, dollars
1	Mobilization			5%	5,381
2	Dust Control	1	CY	$6000	6,000
3	Dewatering	1	SF	$13,000	13,000
4	Trash Boom Anchor Posts	2	SF	$2,000	4,000
5	Excavate for Roadway and Place Dirt at Recharge Berm	481	CY	$30	14,430
6	Aggregate Base (compact sub-base place and compact 6-in of AB)	35		$213	7,455
7	Estimating contingency, conceptual design at 30%			30%	14,139
	Subtotal Direct Construction Cost (rounded)				**$61,000**
	Construction Contingency < $1 million @ 20%			20%	12,200
	Construction Management < $1 million @ 20%			20%	12,200
	Total Construction Cost (rounded)				**$85,000**
	Engineering and Administration < $1 million @ 20%			20%	17,000
	Total Engineering and Administration (rounded)				**$17,000**
	Total Estimated Project Cost				**$102,000**

CONCLUSIONS AND RECOMMENDATIONS

This section will be completed after agency review of this Draft TM.

NEXT STEPS

This section will be completed after agency review of this Draft TM.

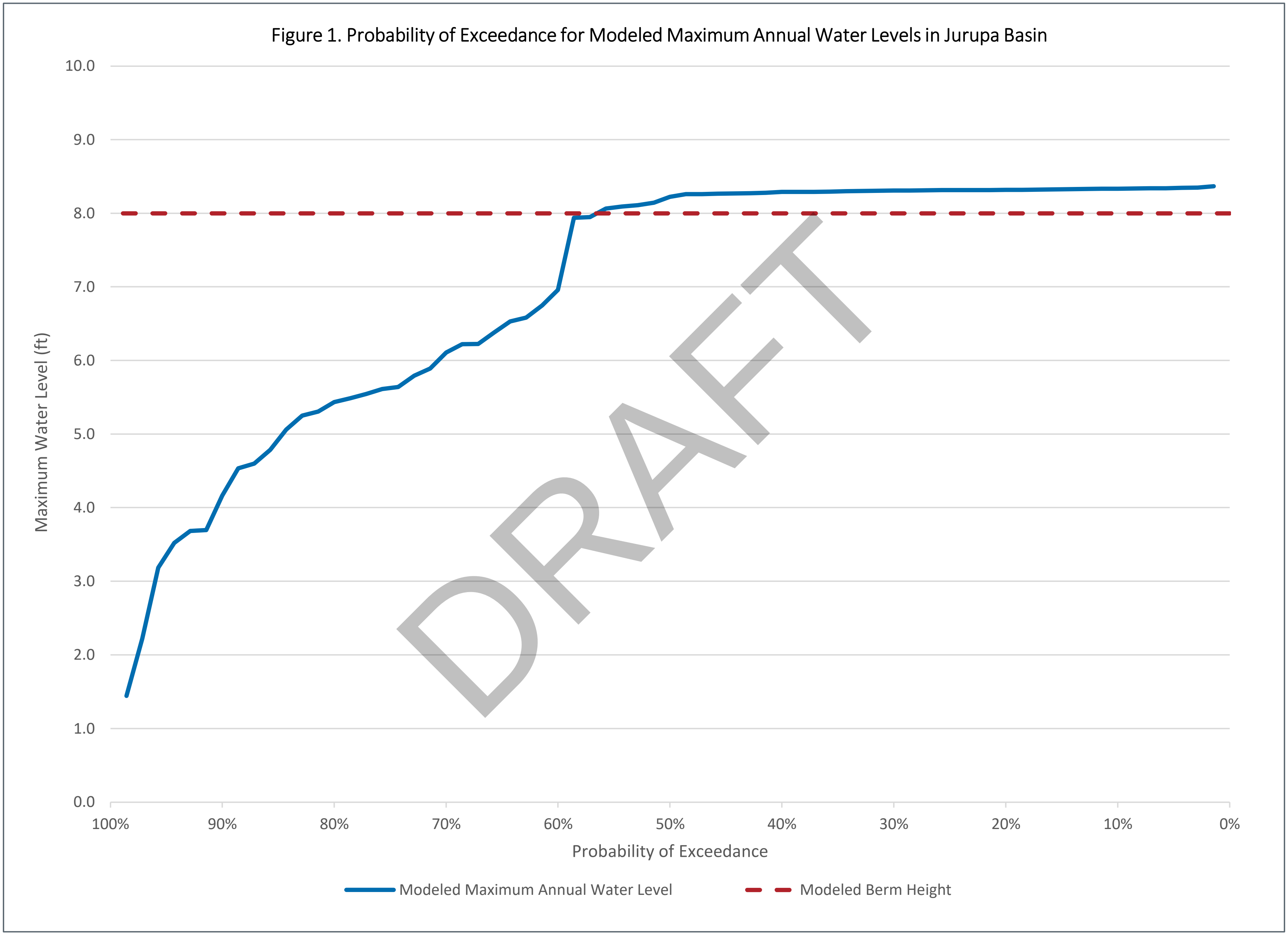
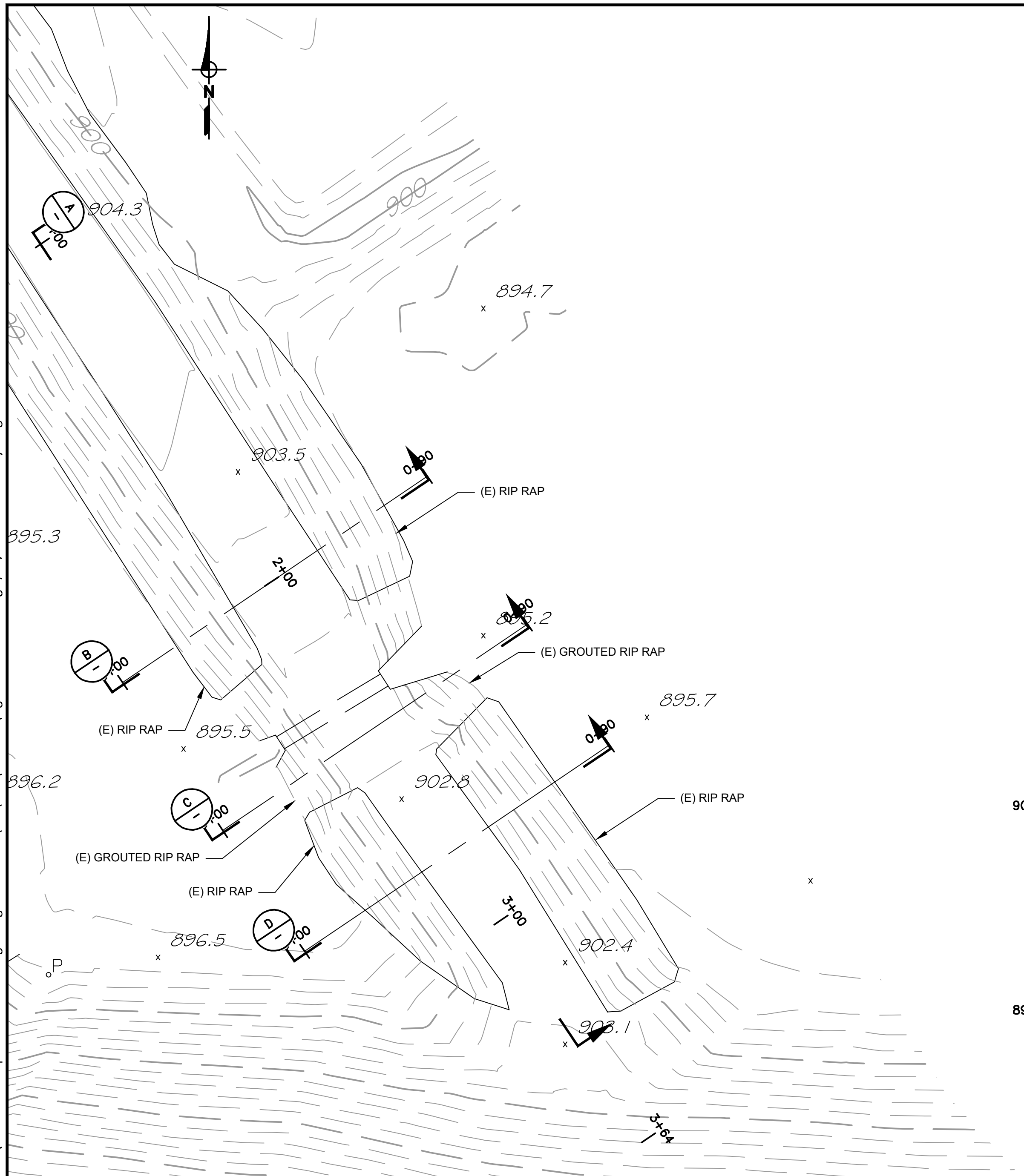


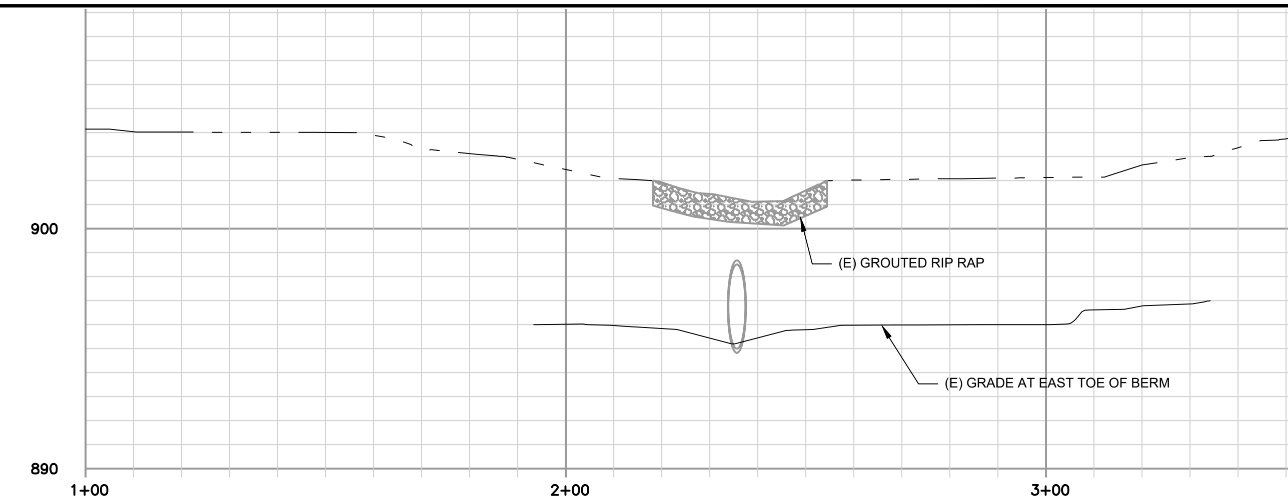
Figure 1. Probability of Exceedance for Modeled Maximum Annual Water Levels in Jurupa Basin
Maximum Water Level (ft)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Exceedance
Modeled Maximum Annual Water Level
Modeled Berm Height
DRAFT



RECHARGE BERM

PLAN

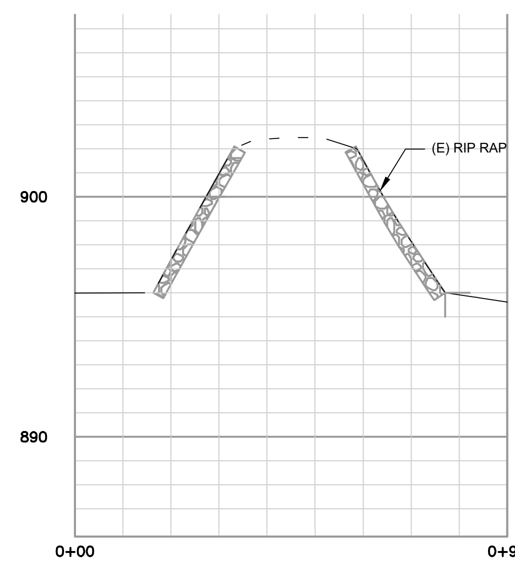
SCALE: 1"=40'



BERM PROFILE

SECTION A

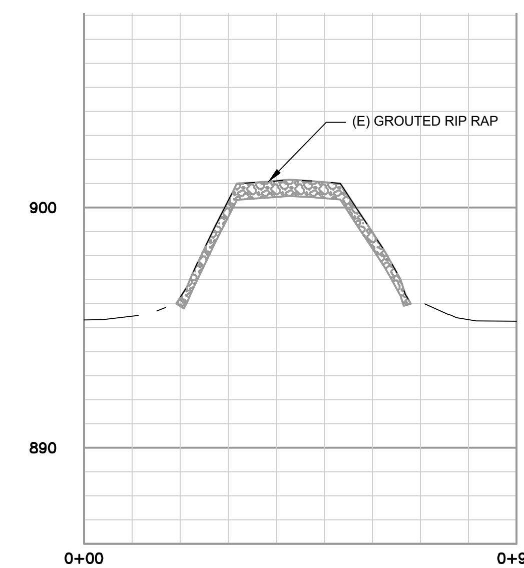
1"=40' HORIZ, 1"=8' VERT



BERM CROSS SECTION

SECTION B

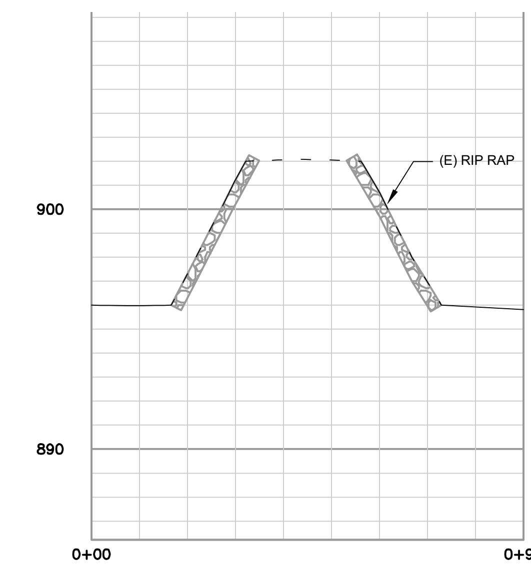
1"=40' HORIZ, 1"=8' VERT



BERM CROSS SECTION

SECTION C

1"=40' HORIZ, 1"=8' VERT



BERM CROSS SECTION

SECTION D

1"=40' HORIZ, 1"=8' VERT

DRAFT

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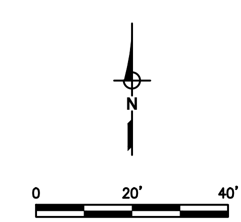

WEST YOST

Figure 2

Existing Conditions
Recharge Berm

Chino Basin Watermaster
Other Recharge Improvements
Project Study

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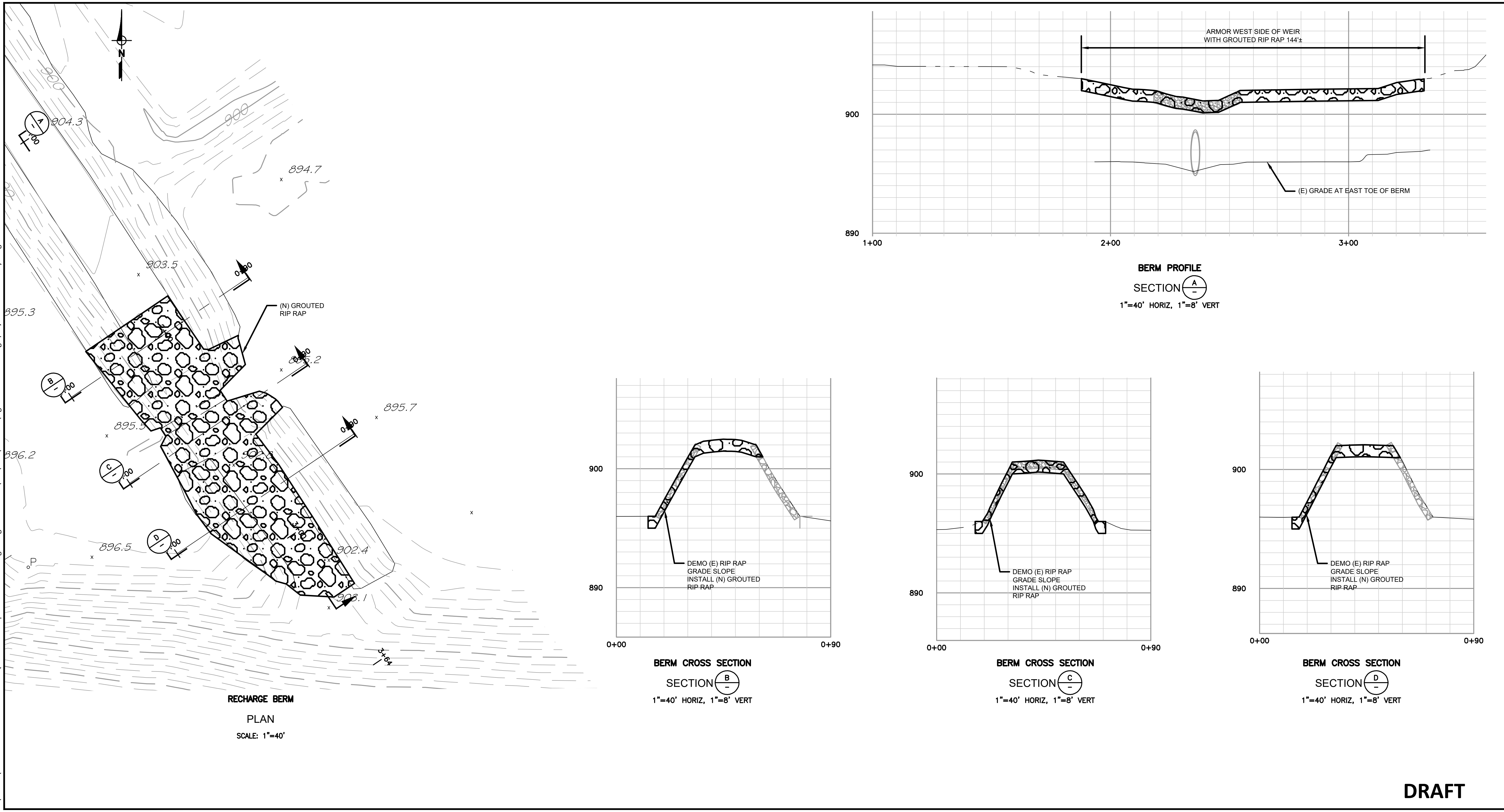
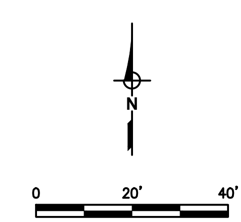


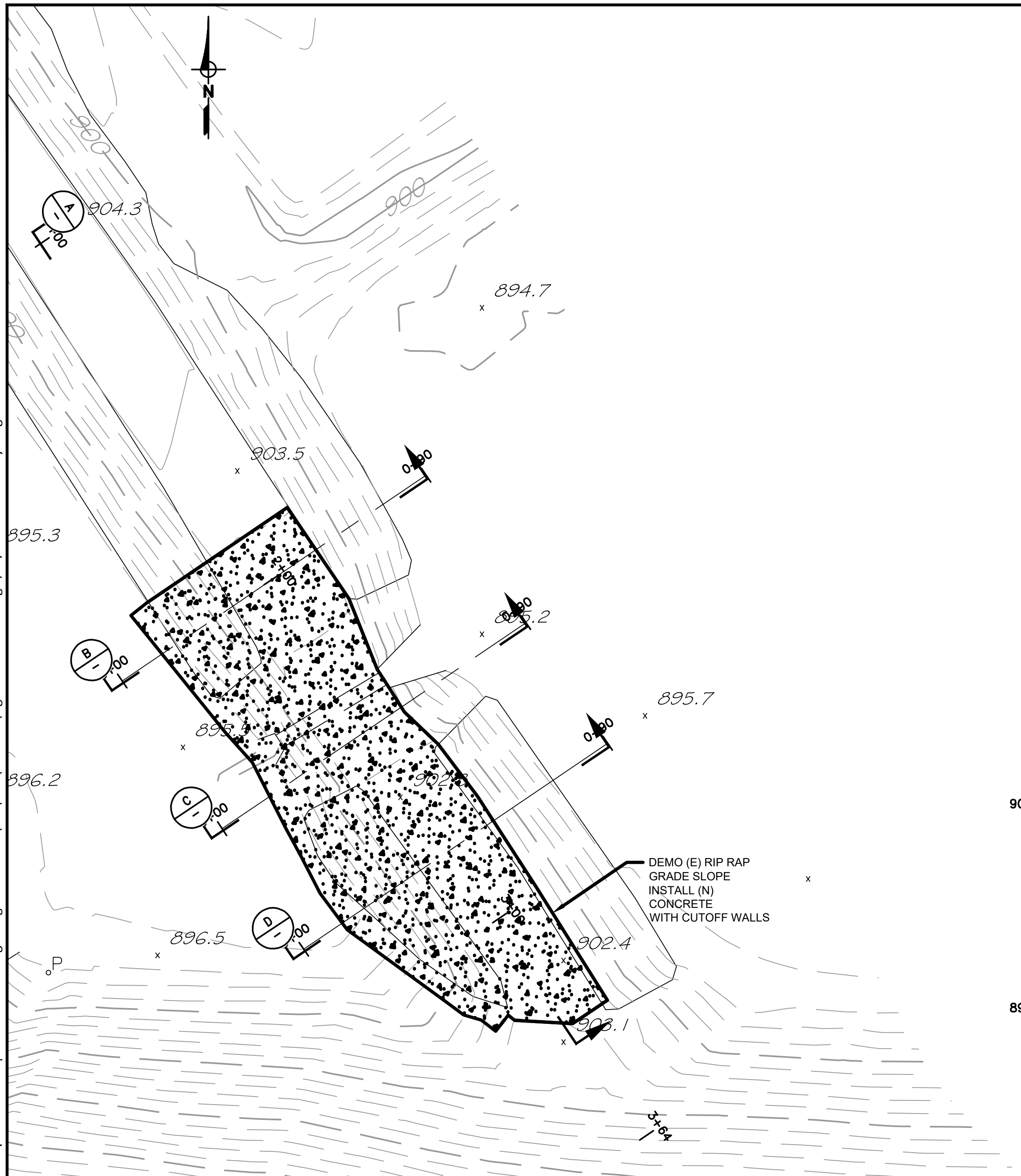


WEST YOST

Figure 3

Alternative 1
Grouted Rip Rap

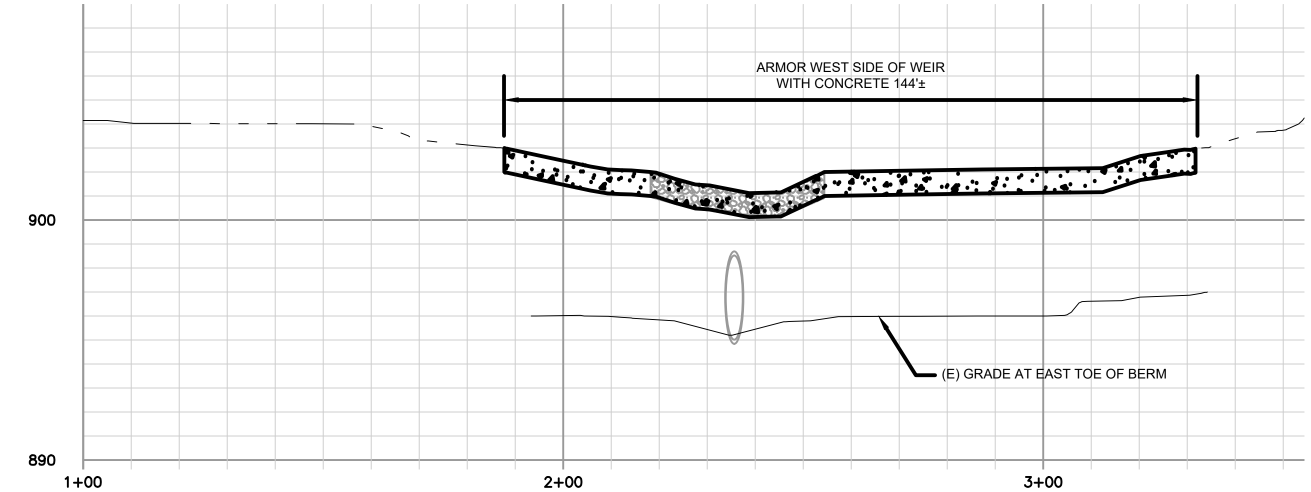
Chino Basin Watermaster
Other Recharge Improvements
Project Study



RECHARGE BERM

PLAN

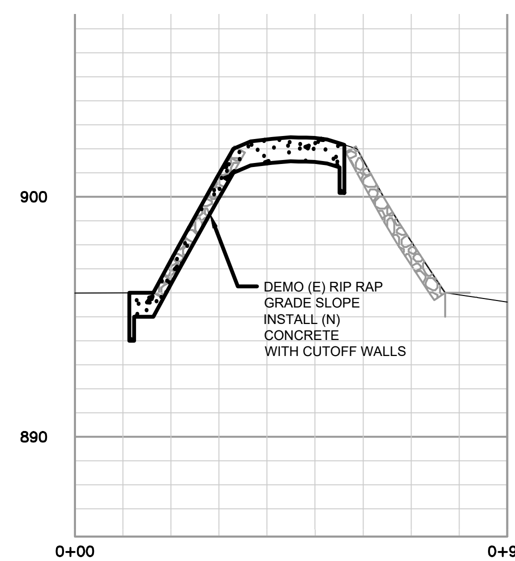
SCALE: 1"=40'



BERM PROFILE

SECTION A

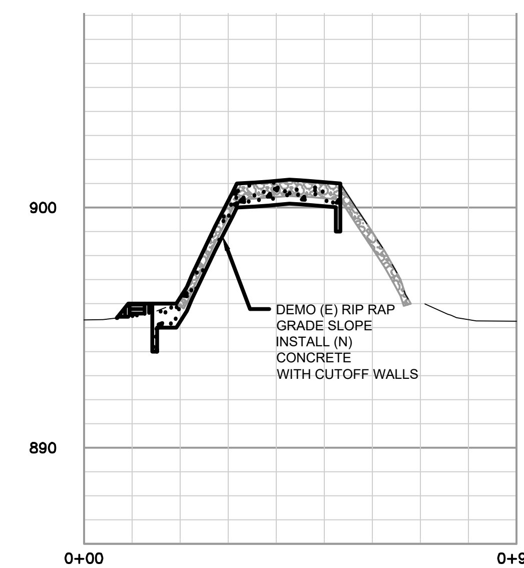
1"=40' HORIZ, 1"=8' VERT



BERM CROSS SECTION

SECTION B

1"=40' HORIZ, 1"=8' VERT



BERM CROSS SECTION

SECTION C

1"=40' HORIZ, 1"=8' VERT

BERM CROSS SECTION

SECTION D

1"=40' HORIZ, 1"=8' VERT

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N

0 20' 40'

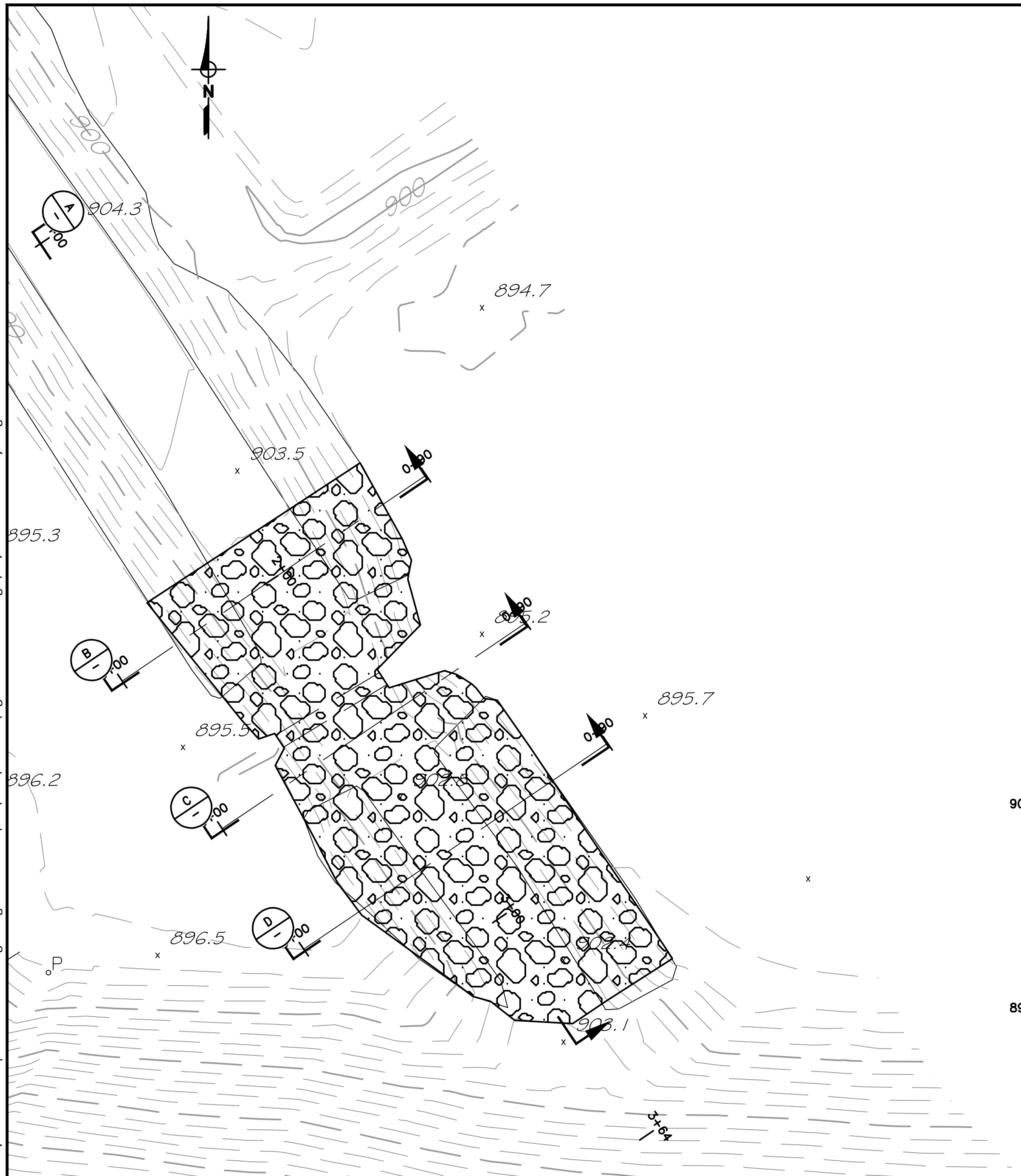
SCALE IN FEET

WEST YOST

Figure 4

Alternative 2
Concrete

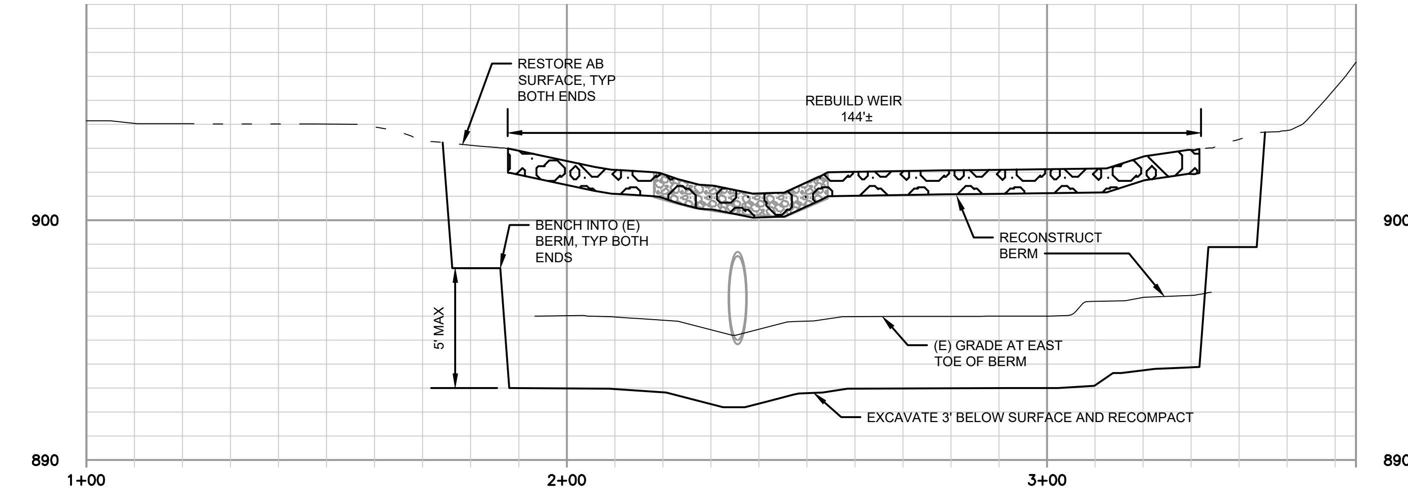
Chino Basin Watermaster
Other Recharge Improvements
Project Study



RECHARGE BERM

PLAN

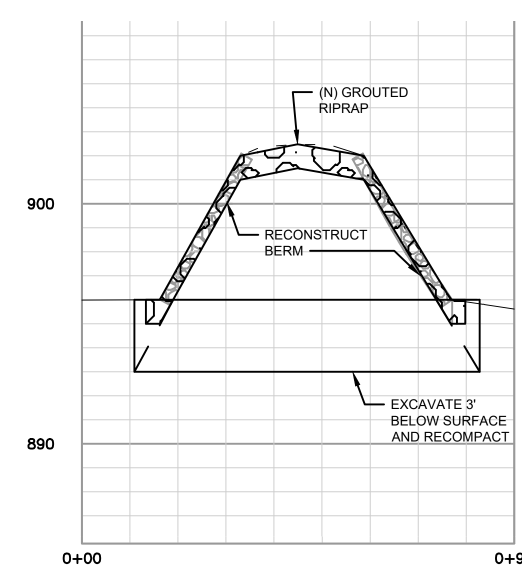
SCALE: 1"=40'



BERM PROFILE

SECTION A

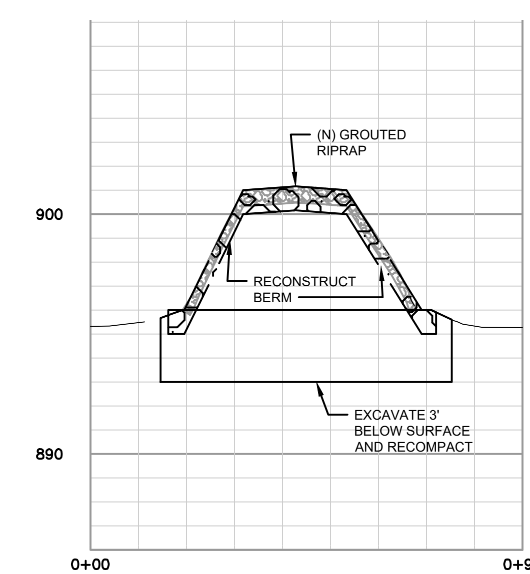
1"=40' HORIZ, 1"=8' VERT



BERM CROSS SECTION

SECTION B

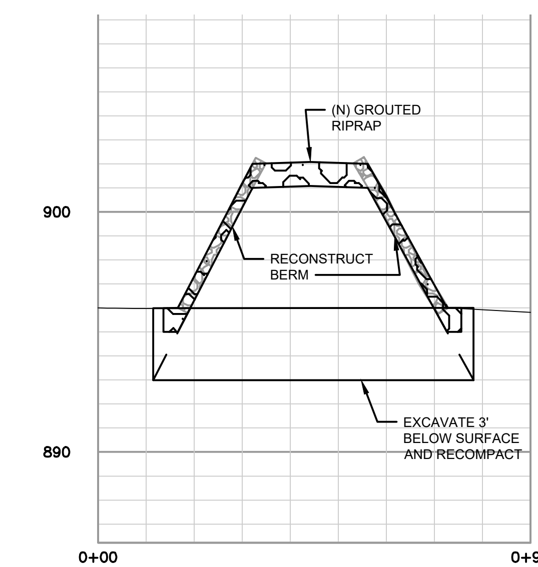
1"=40' HORIZ, 1"=8' VERT



BERM CROSS SECTION

SECTION C

1"=40' HORIZ, 1"=8' VERT



BERM CROSS SECTION

SECTION D

1"=40' HORIZ, 1"=8' VERT

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0 20' 40'

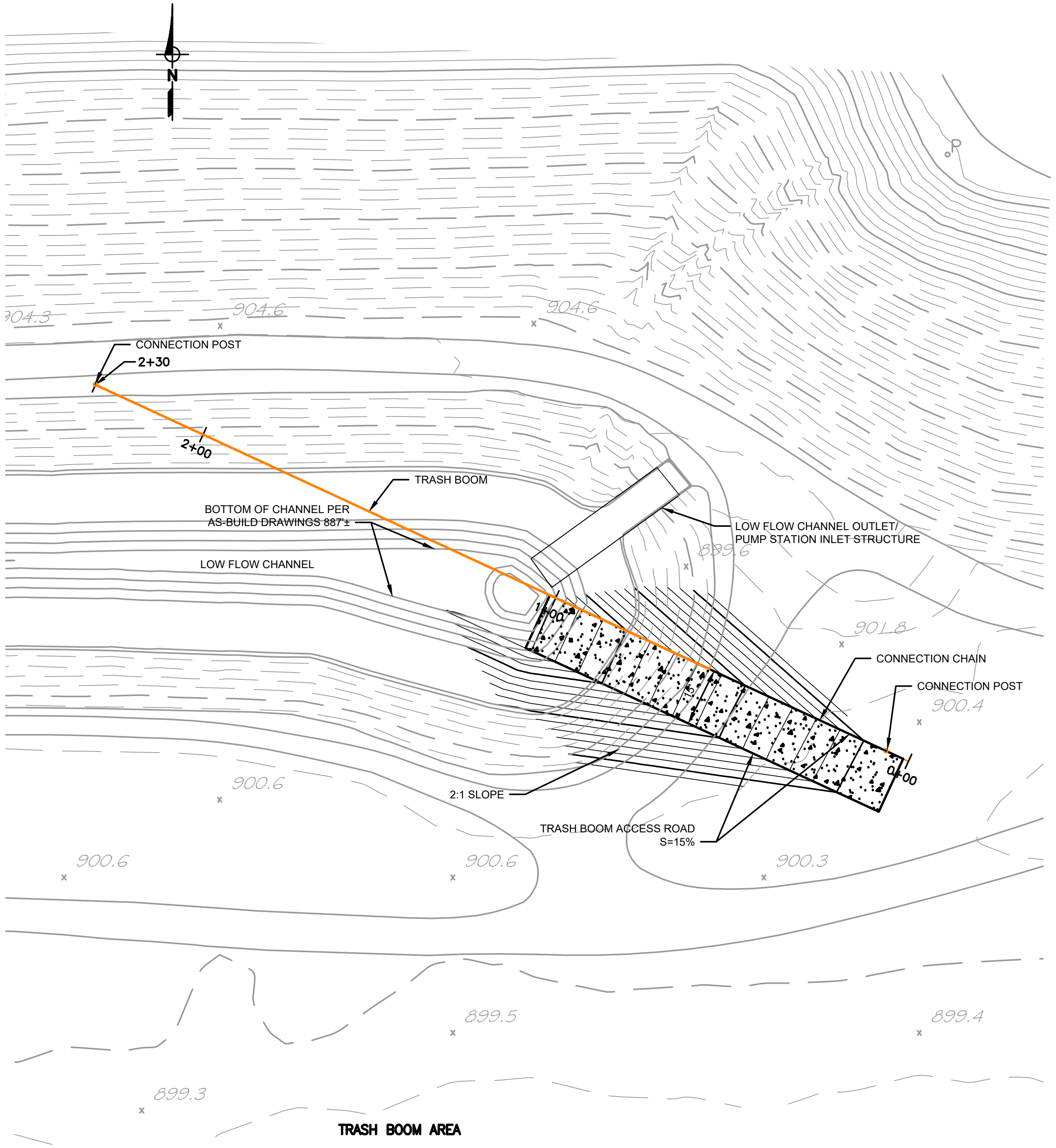
SCALE IN FEET

Figure 5

Alternative 3
Rebuild Weir Section

WEST YOST

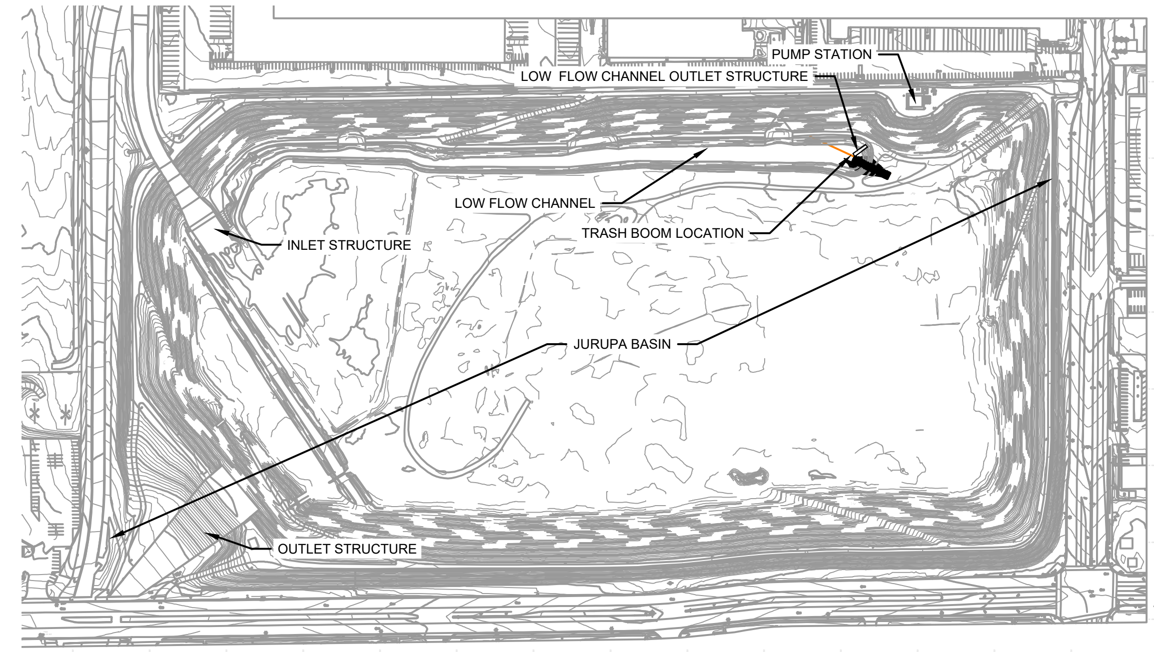
Chino Basin Watermaster
Other Recharge Improvements
Project Study



TRASH BOOM AREA

PLAN

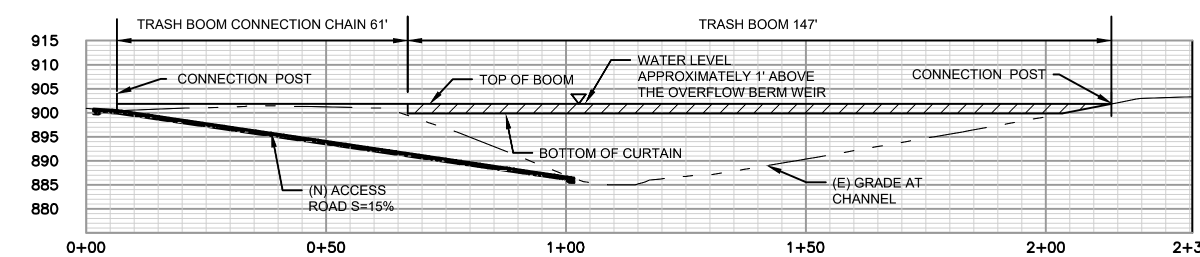
SCALE: 1"=40'



OVERALL AREA

PLAN

SCALE: 1"=500'



TRASH BOOM AND ACCESS ROAD

PROFILE

SCALE:
V: 1"=40'
H: 1"=40'

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0 20' 40'
SCALE IN FEET

Figure 6

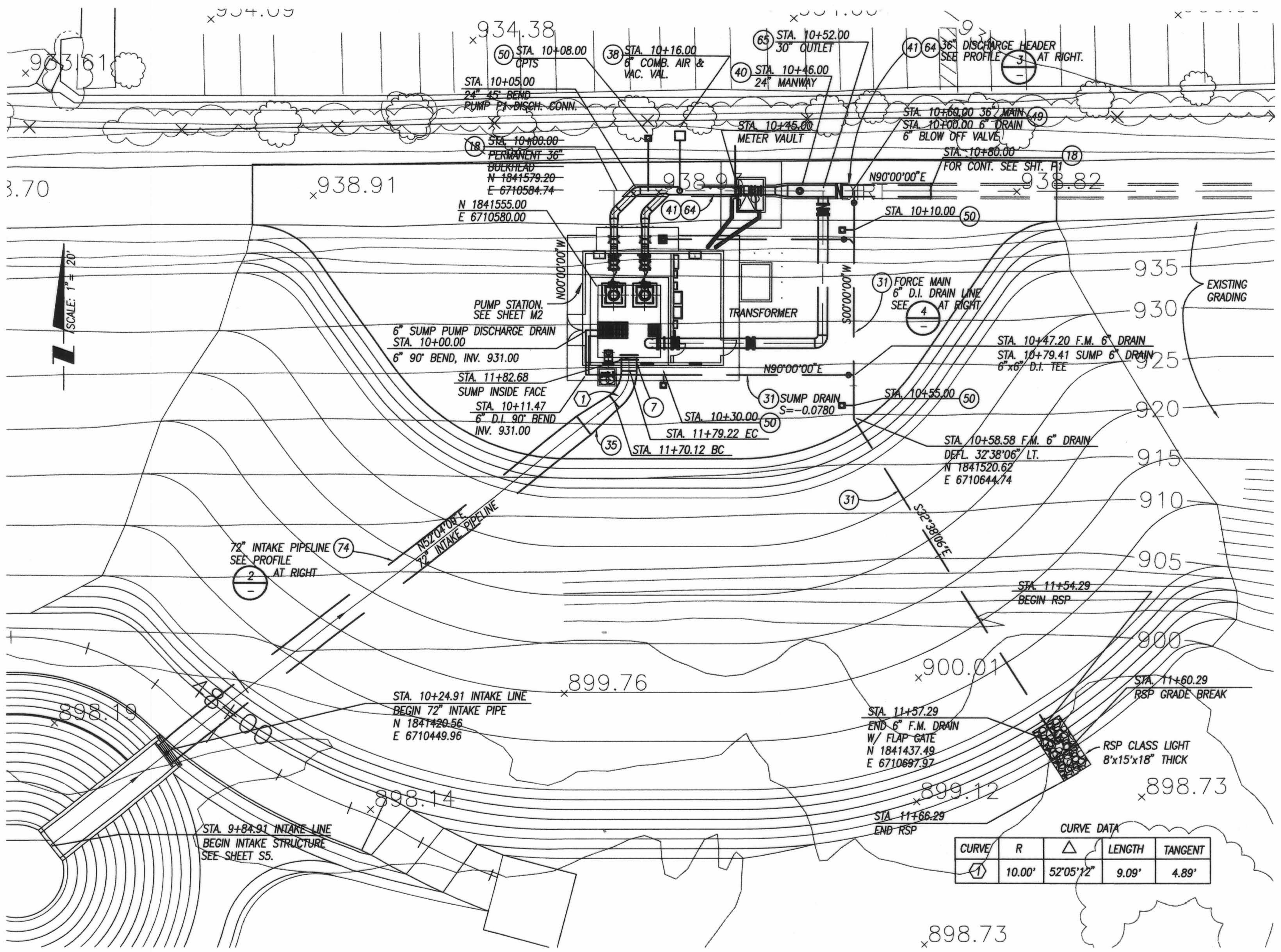
Trash Boom and Access Road
Low Flow Channel

WEST YOST

Chino Basin Watermaster
Other Recharge Improvements
Project Study

Appendix A

As-Built Drawings and Aerial Survey

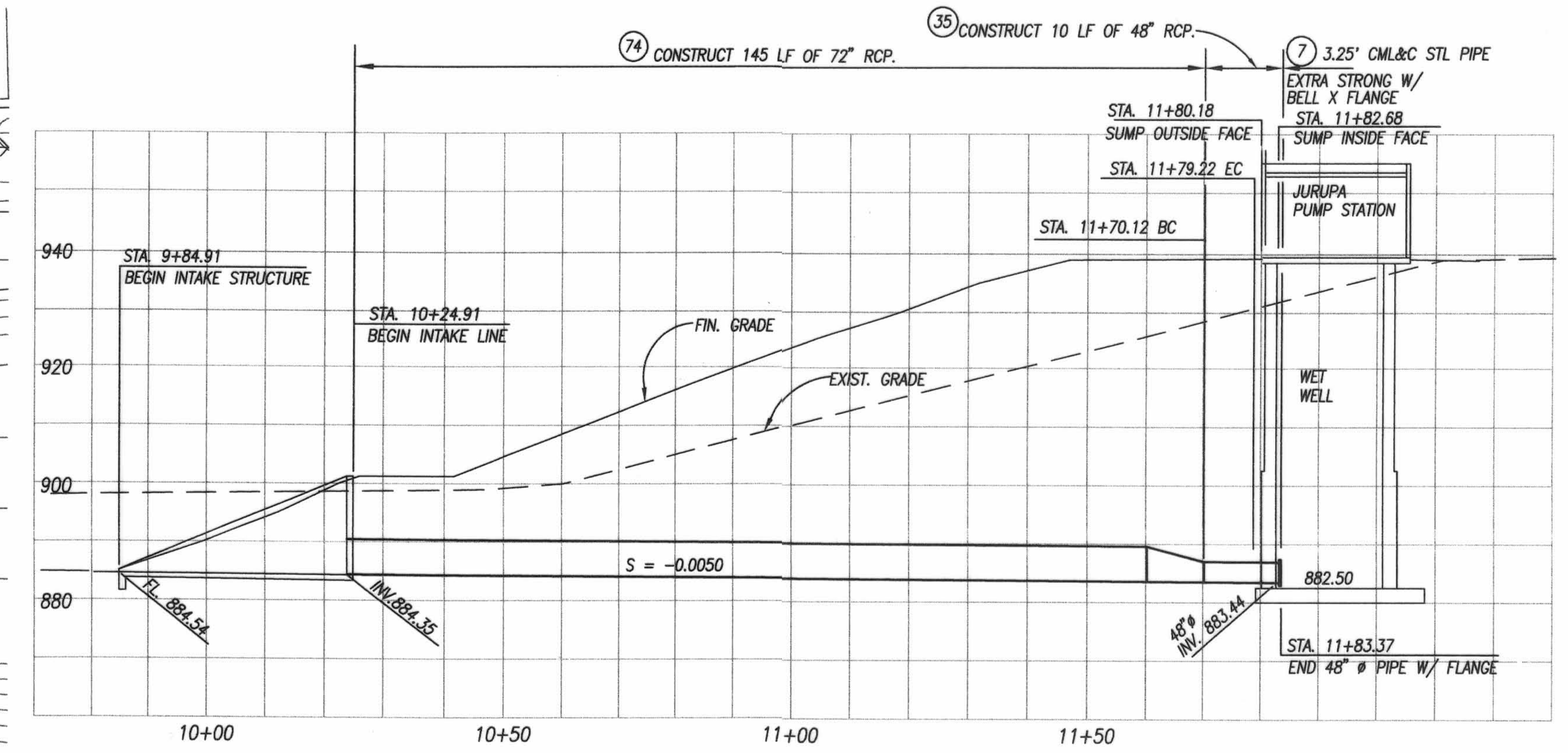


CURVE DATA

CURVE	R	Δ	LENGTH	TANGENT
1	10.00'	52°05'12"	9.09'	4.89'

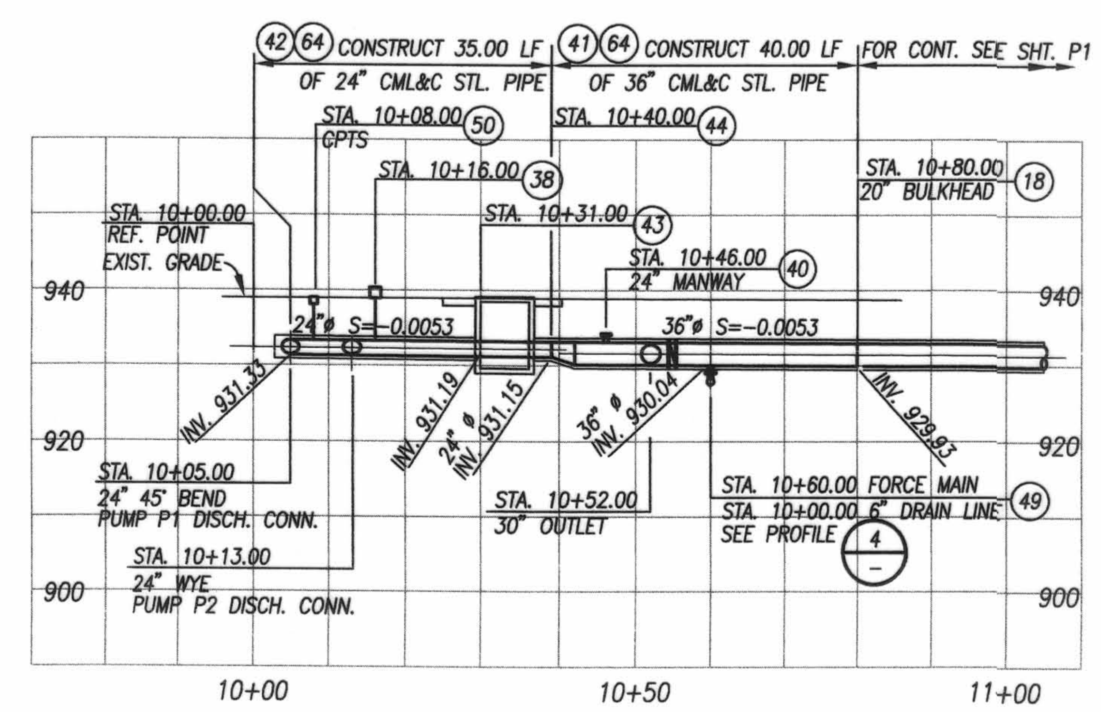
SITE PLAN 1

SCALE : 1" =20'



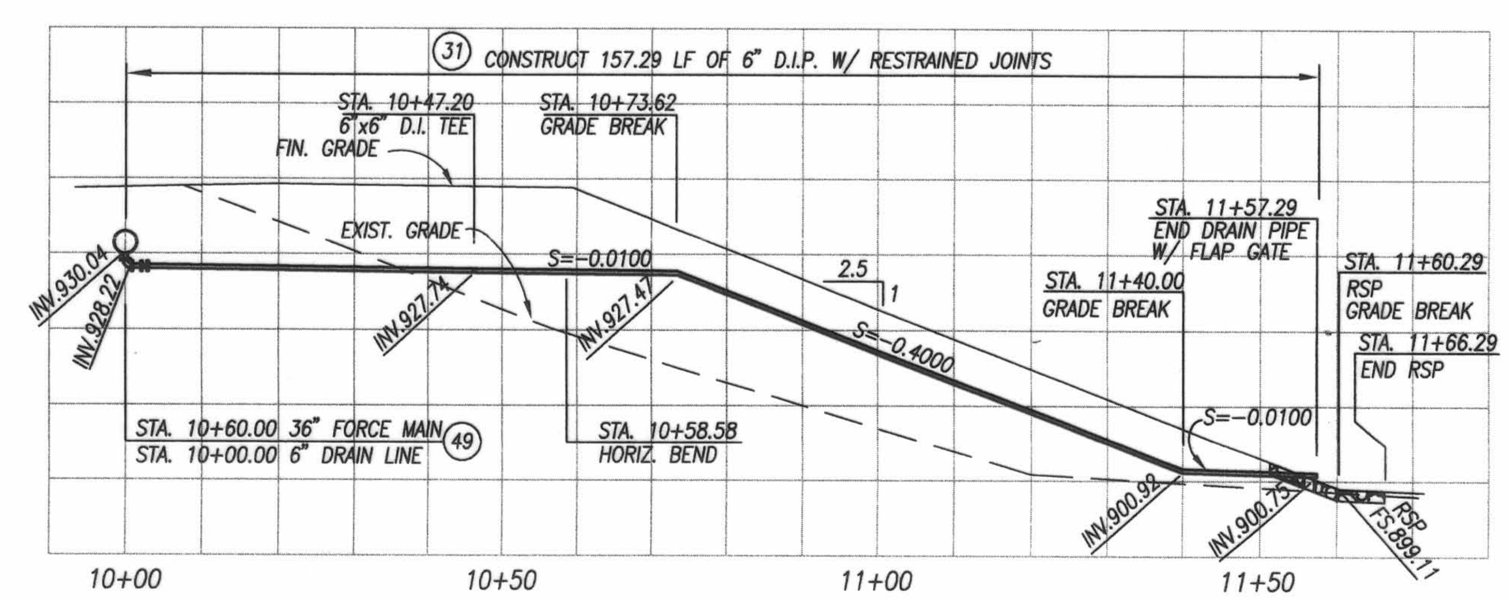
INTAKE PIPELINE PROFILE 2

SCALE : 1" =20'



DISCHARGE HEADER PROFILE 3

SCALE : 1" =20'



FORCE MAIN DRAIN LINE PROFILE 4

SCALE : 1" =20'

GENERAL MECHANICAL CONSTRUCTION NOTES

(1) VERTICAL TURBINE/MIX FLOW PUMP 9000 GPM x 108' TDH 1175 RPM W/ SUCTION BELL, PUMP COLUMN, ANCHOR BRACKETS, AND APPURTENANCES. PUMP COLUMN (FIN. FLOOR TO SUCTION BELL INLET) LENGTH 55.83'

(2) ELECTRICAL MOTOR SIZED FOR THE ABOVE PRESCRIBED PUMP SERVICE CONDITION, 300 HP MIN.

(3) PUMP BASE PLATE FOR SUPPORTING, DESIGNED BY THE PUMP MANUFACTURER, 2" THICK MINIMUM, FURNISHED WITH PUMP, SEE DETAIL 1/M5

(4) SUMP PUMP 450 GPM x 60 FT TDH, 15 HP MINIMUM EQUIPPED WITH 90° ANCHORED ELBOW, 60' (MIN.) POWER & CONTROL CABLES AND LIFTING CABLE, SLIDE RAILS, SLIDE RAIL BRACKETS AND ANCHORS (@ 10' C.C.), BASE CLAW AND ALL NEEDED APPURTENANCES.

(5) (NOT USED)

(6) TEMPORARY BASE STEEL PLATE W/ APPURTENANCES PER SPECS.

(7) 48" CML&C STEEL PIPE/RCP ADAPTER, WALL t=1/2" MIN., SEE DETAIL 5/M5

(8) 20" STEEL PIPE, FLG. x FLG., CL. 150, WALL t=0.3/8" MIN., CEMENT MORTAR LINED & EPOXY COATED.

(9) 20" DISCHARGE MANIFOLD, FLG. x GROOVE ENDS, STEEL t=3/8" MIN. CEMENT MORTAR LINED & EPOXY COATED.

(10) HARNESS JOINT ASSEMBLY W/ TWO 316 STAINLESS STEEL STUD SYSTEM FOR PRESSURE 150 PSI, DESIGNED AND FABRICATED PER AWWA M-11 DESIGN MANUAL

(11) 20" DISCHARGE MANIFOLD, FLG. x WELD JOINT, STEEL t=0.375" MIN. CEMENT MORTAR LINED & EPOXY COATED.

GENERAL MECHANICAL CONSTRUCTION NOTES (CONT.)

(12) 20" DISCHARGE MANIFOLD, 45° BEND, WELD JOINTS, STEEL t=0.375" MIN., CML & EPOXY COATED. (VERIFY PUMP MFR'S DISCHARGE HEAD DATA PRIOR TO FABRICATION)

(13) 20" DISCHARGE MANIFOLD, WELD x GROOVE JOINT, STEEL t=0.375" MIN., CML & C FOR BURIED SERVICE, CML & EPOXY COATED FOR ABOVEGROUND SERVICE.

(14) 20" x 24" CML & C STEEL PIPE REDUCER, t=0.25" MIN.

(15) 24" CML & C PIPE WYE OUTLET (OR 45° BEND) PER PLANS, FABRICATED PER AWWA M-11 MANUAL.

(16) 24" CML & C COMBINED HORIZ. AND VERT. 45° BEND

(17) 2" COMBINED AIR AND VACUUM RELIEF VALVE, SEE DETAIL 7/M6

(18) 36" CML & C STL. BULKHEAD AT PIPE END FOR PRESSURE TESTING (INCL. CUTTING OFF FOR CLOSURE CONN.) OR FUTURE CONNECTION, SEE DETAIL 10/M6

(19) 20" SWING CHECK VALVE W/ LEVER, WEIGHT, AIR CUSHION DEVICES AND APPURTENANCES, FLG. x FLG., CL. 125.

(20) 20" AWWA BUTTERFLY VALVE, CL. 150 W/ HAND WHEEL

(21) 3" COMBINED AIR AND VACUUM RELIEF VALVE, SEE DETAIL 7/M6

(22) ADJUSTABLE PIPE SUPPORT, SEE DETAIL 9/M6

(23) (NOT USED)

(24) 6" D.I. PIPE AND FITTINGS, W/ FLANGED JOINTS

(25) 6" D.I.P. FLANGED WALL FITTING, SEE DETAIL 8/M5

(26) 6" D.I. PIPE WALL SUPPORTS @ 9' O.C., SEE DETAIL 6/M5

(27) 1/2" AIR RELEASE LINE ASSEMBLY, COPPER PIPING TYPE K, W/ TAPPING SADDLE, BALL VALVE AND APPURTENANCES.

(28) 6" BALL CHECK VALVE W/ CL. 125 FLANGES, 145 (MIN.) PSI RATING.

(29) 6" GATE VALVE, NRS, W/ VALVE BOX & APPURTENANCES, SEE DETAIL 6/M6

(30) 6" VICTAULIC COUPLING, D.I., STYLE 31

(31) 6" D.I.P. & FITTINGS W/ RESTRAINED JOINTS PER DETAILS 1/M6 & 6/M8

GENERAL MECHANICAL CONSTRUCTION NOTES (CONT.)

(32) WALL VENTILATOR PER SPECS.

(33) IN-LINE DIRECT DRIVE VENTILATOR, LOREN COOK MODEL 14EV 11D 1140 RPM W/ 1/4 HP MOTOR PER SPECS.

(34) PRESSURE GAUGE W/ APPURTENANCES PER DETAIL 2/M7

(35) 48" RCP. PER AWWA C-302 W/ STEEL JOINT RING & RUBBER GASKET JOINT, DESIGNED & FABRICATED BY PIPE MFR. FOR EARTH COVER PER PLANS & SPECS.

(36) 5" GUARD POST, SEE DETAIL 11/M6

(37) (NOT USED)

(38) 6" COMBINED AIR AND VACUUM RELIEF VALVE W/ PIPING AND APPURTENANCES, SEE DETAILS 8/M6 & 1/M7

(39) 20" BLIND STEEL FLANGE, 150#, CLASS D.

(40) CONSTRUCT 24" DIA. CML & C STEEL PIPE MANWAY AND APPURTENANCES PER DETAIL 1/M7

(41) CONSTRUCT 36" DIA. CML & C STEEL PIPE WITH 3/16" STEEL WALL AND WELDED JOINTS PER DETAILS 1/M6 & 2/M6

(42) CONSTRUCT 24" DIA. CML & C STEEL PIPE WITH 3/16" STEEL WALL AND WELDED JOINTS PER DETAILS 1/M6 & 2/M6

(43) 6' x 8' PRECAST CONCRETE VAULT WITH 4'x4' ALUM. ACCESS DOOR, ALL TRAFFIC LOAD GRADE, SEE DETAIL 2/M4

(44) 36" x 24" CML & C ECCENTRIC STEEL REDUCER, FLAT ON TOP W/ STEEL t=3/16"

(45) 24" MAGNETIC FLOW METER WITH APPURTENANCES PER SPECS.

(46) 24" RESTRAINED DISMANTLING JOINT ASSEMBLY WITH CL. D FLANGES AND FOUR TYPE 316 STAINLESS STEEL STUDS, DRESSER STYLE 131 OR APPROVED EQUAL.

GENERAL MECHANICAL CONSTRUCTION NOTES (CONT.)

(47) 4' x 4' PRECAST CONCRETE VAULT WITH 30" DIA. C.I. COVER AND FRAME, ALL TRAFFIC LOAD GRADE, SEE DETAIL 3/M4

(48) 36" BUTTERFLY VALVE WITH AWWA OPERATING NUT AND VALVE BOX PER DETAILS 6/M6 AND 2/M8

(49) CONSTRUCT 6" BLOW OFF VALVE, PIPING AND APPURTENANCES, SEE DETAILS 5/M6 & 1/M7, EXCEPT PIPING PER SHEET M1.

(50) CONSTRUCT 2-WIRE CATHODIC TEST STATION PER DETAIL 1/M8 JOINTS PER DETAILS 5/M8 & 6/M8

(51) INSTALL 20" D.I. VICTAULIC COUPLING, STYLE 77.

(52)~(63) (NOT USED FOR PUMP STATION)

(64) CONSTRUCT CONCRETE ENCASEMENT AROUND PIPE, SEE DETAIL 3/M7

(65) 36" x 30" CML & C STEEL TEE OUTLET, SEE DETAIL 1/M7

(66) 30" BUTTERFLY VALVE WITH AWWA OPERATING NUT AND VALVE BOX PER DETAILS 6/M6 AND 2/M8

(67) CONSTRUCT 30" DIA. CML & C STEEL PIPE AND FITTINGS WITH 3/16" STEEL WALL AND WELDED JOINTS PER DETAILS 1/M6 & 2/M6

(68) 30" WIDE ARCH RUBBER EXPANSION JOINT STYLE 1015 MAXI-JOINT W/ VITON TUBE AND COVER AND FIBERGLASS REINFORCEMENT AS MANUFATURED BY GENERAL RUBBER CORP. ALL BOLTS & NUTS TO BE 316 S.S.

(69) 44" O.D. x 3/4" STEEL ANCHOR COLLAR WELDED TO STEEL PIPE.

(70) 30" CML & C STEEL PIPE AND FITTINGS WITH STEEL t= 3/8" AND FLANGED JOINTS.

(71) 2'x2'x3' DEEP PRECAST CONCRETE DRAIN BOX W/ C.I. GRATE, TRAFFIC WEIGHT.

GENERAL MECHANICAL CONSTRUCTION NOTES (CONT.)

(72) 1 1/2" DRAIN LINE & FITTING, PVC SCH. 40. 18" COVER SLOPE @ 2% TO CATCH BASIN OR DAYLIGHT.

(73) 8" VENT PIPE & FITTINGS, PVC SCH. 40 W/ RISER PER DETAIL 4/M5

(74) 72" RCP. INCL. 72" x 48" ECC. REDUCER W/ STEEL JOINT RING & RUBBER GASKET JOIN, PER AWWA C-302, DESIGNED & FABRICATED BY PIPE MANUFACTURER FOR EARTH COVER PER PLANS & SPECS.

NOTE: Elevations on as-built drawings are 2.6' lower than elevations shown on Aero Tech Topographic Survey

AS-BUILT DRAWING

DIGALERT

DIAL TOLL FREE
1-800-227-2600
AT LEAST TWO DAYS BEFORE YOU DIG

UNDERGROUND SERVICE ALERT OF SOUTHERN CALIFORNIA

J:\10188.00\dwg\prsw0001.dwg 7/7/2005 4:48:58 PM PDT

REV.	DATE	BY	DESCRIPTION
A	07/05/05	B.S.G.	AS-BUILT

		Date
Designed	T.O.	7/28/03
Drawn	L.E.G.	7/28/03
Checked	T.O.	7/28/03

REGISTERED PROFESSIONAL ENGINEER ROBERT F. SEEMAN No. 21646 Exp. 9/30/05 CIVIL STATE OF CALIFORNIA

PREPARED BY:

Tettemer & Associates
consulting engineers
ENGINEERING - MANAGEMENT - PLANNING
19 TECHNOLOGY DRIVE, IRVINE, CALIFORNIA 92618
Tel: (949) 923-6277 Fax: (949) 923-6077
a division of The Keith Companies, Inc.

SCALE
AS SHOWN
Bar Scale shown below is one inch on original drawing. If NOT one inch on this sheet, adjust scales accordingly.
0" — 1"

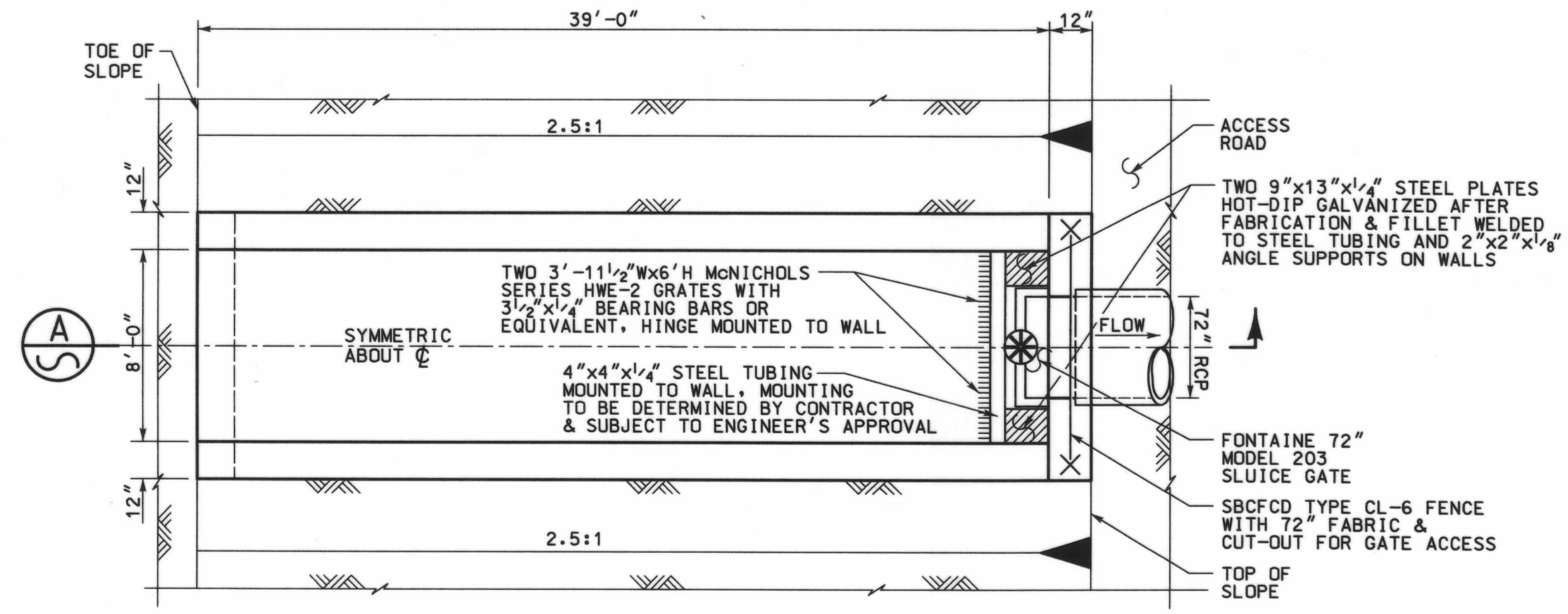
INLAND EMPIRE UTILITIES AGENCY
A Municipal Water District

LOCATION
9400 Cherry Avenue, Building A
Fontana, California 92335
Telephone (909) 357-0241

MAILING ADDRESS
Post Office Box 697
Rancho Cucamonga, California 91730

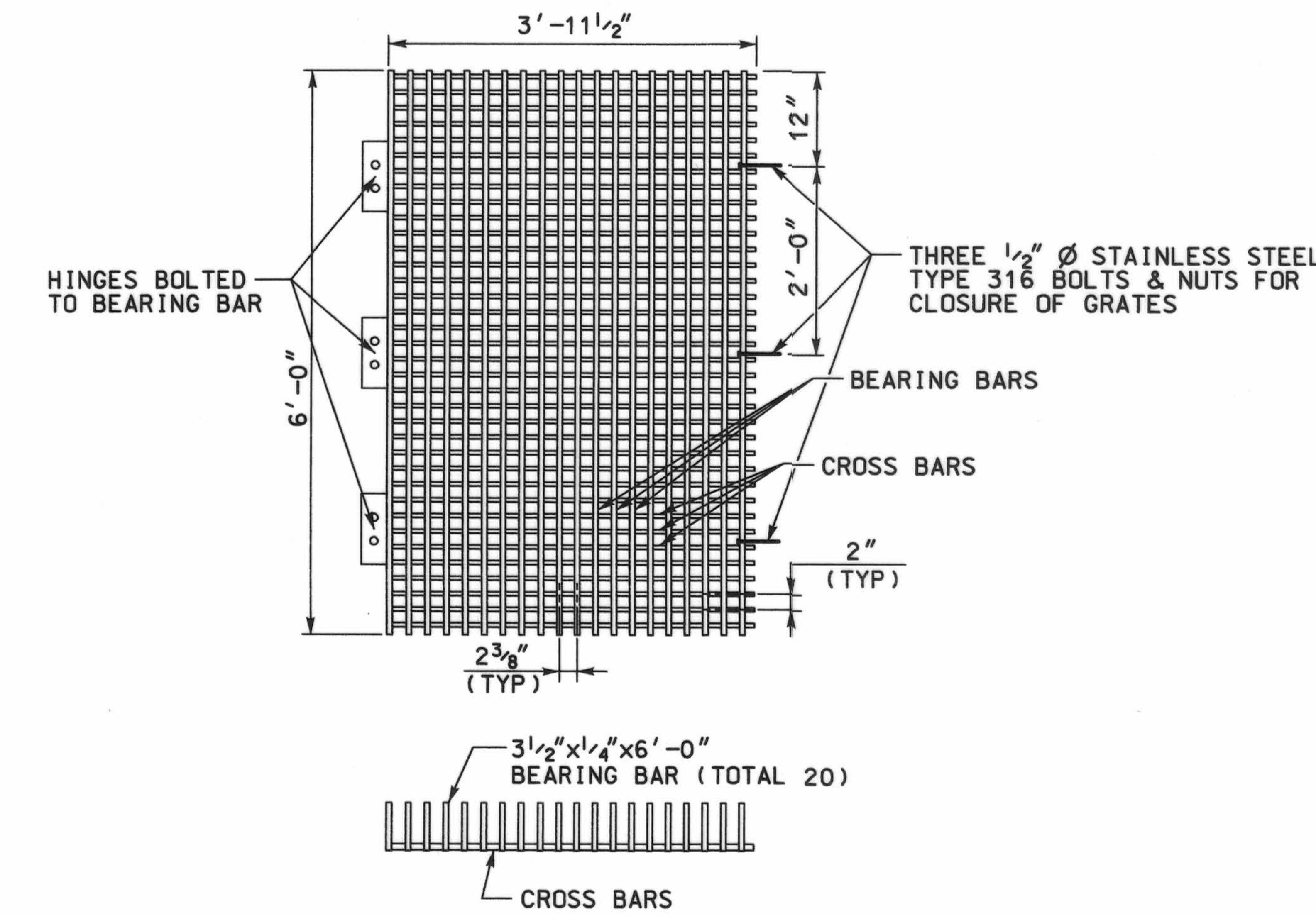
CHINO BASIN FACILITIES IMPROVEMENT PROJECT
JURUPA PUMP STATION
SITE PLAN

SHEET
M1
13 OF 27 SHTS
DWG. NUMBER
D8004-014



PLAN - INLET

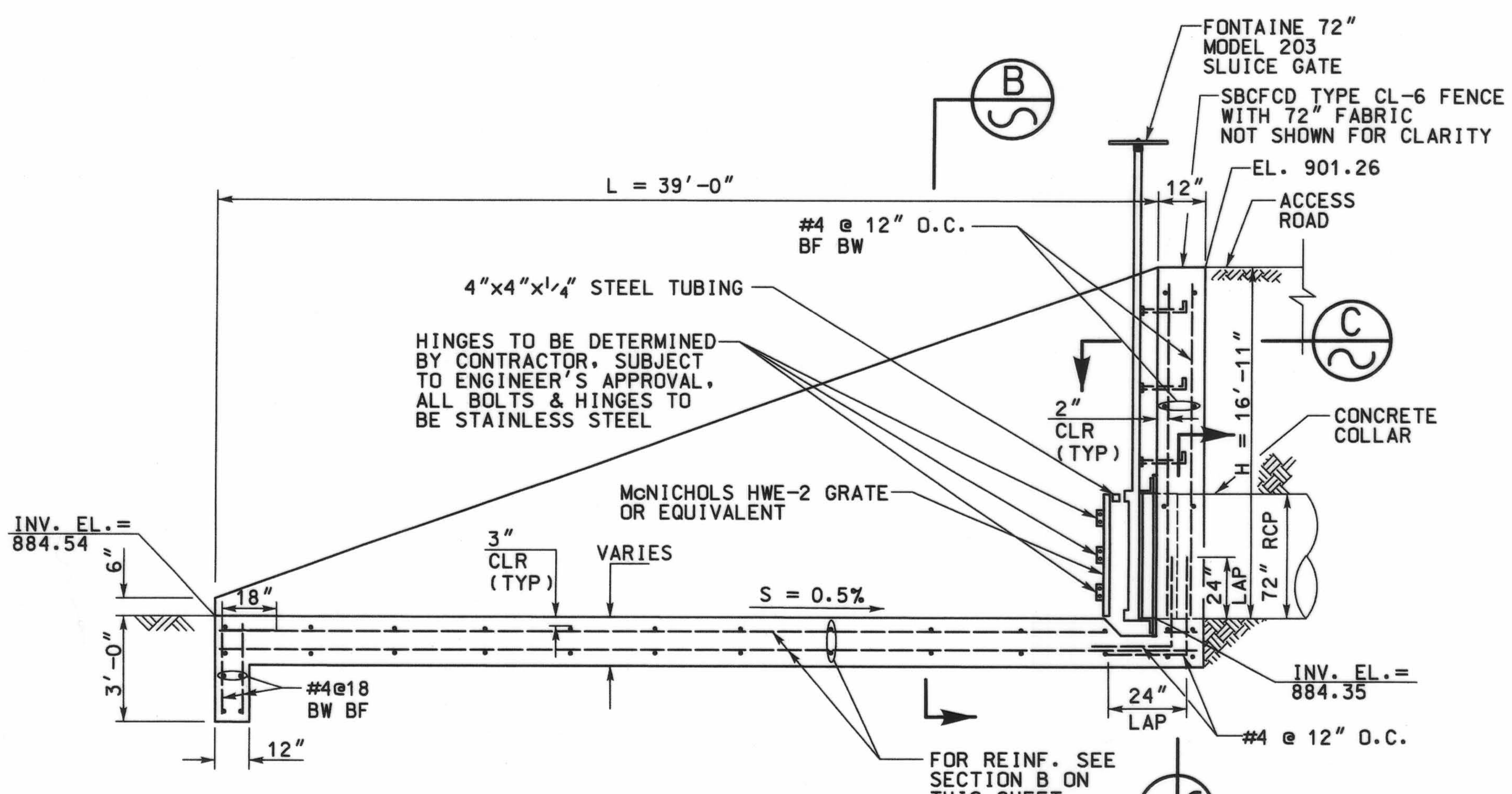
N.T.S.



McNICHOLS SERIES HWE-2 GRATE

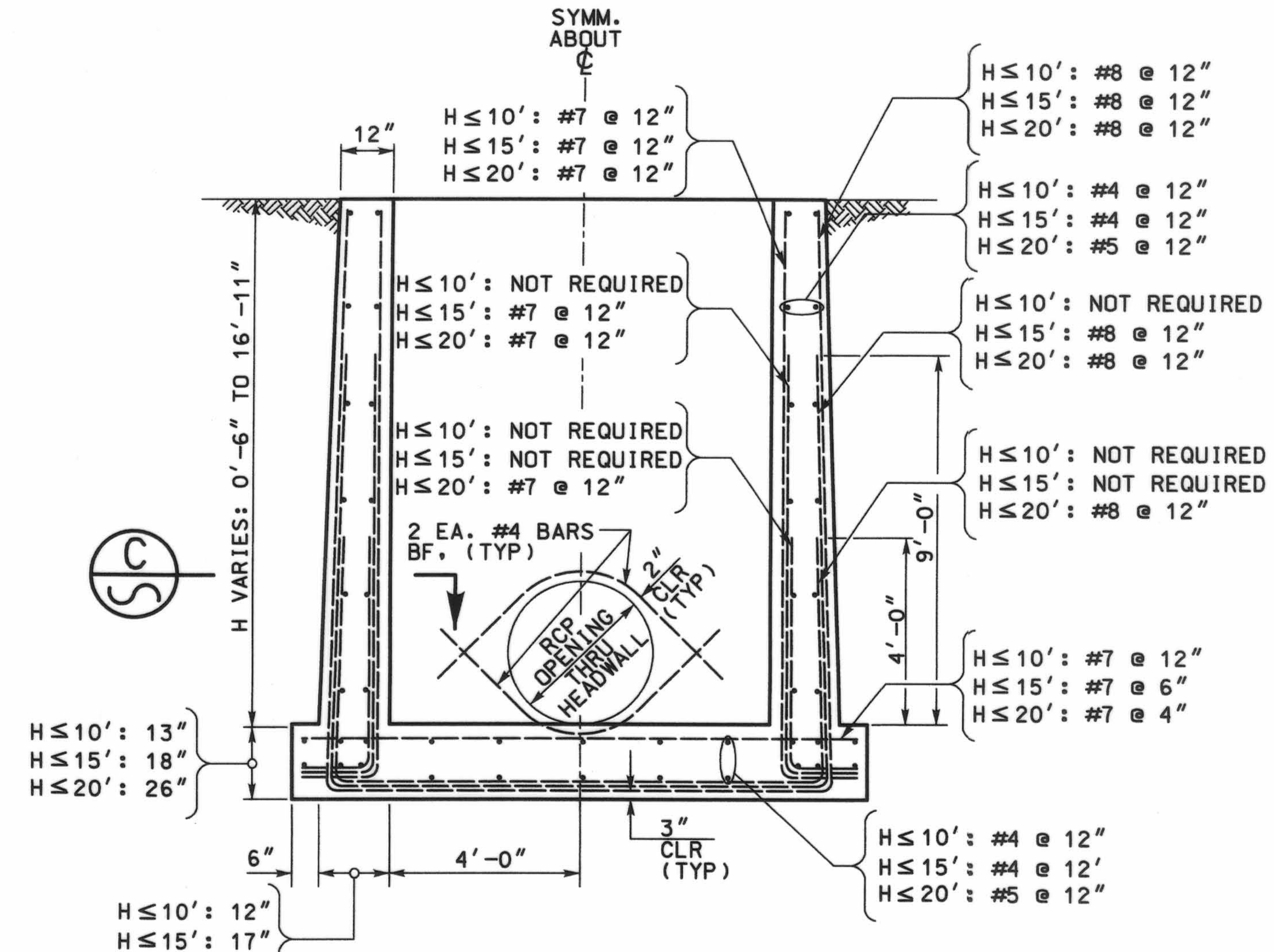
N.T.S.

ALL GRATE STRUCTURAL STEEL MEMBERS SHALL BE HOT-DIP GALVANIZED AFTER FABRICATION PRIOR TO INSTALLATION IN THE FIELD.



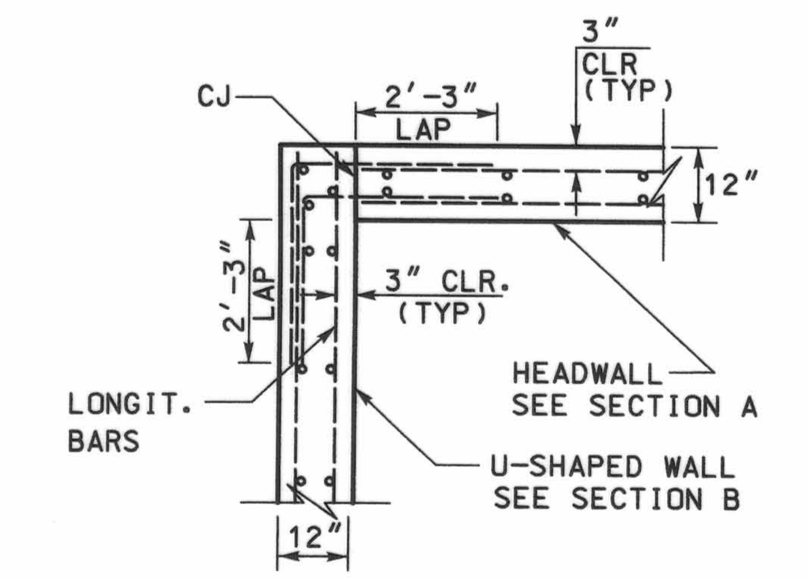
SECTION ELEVATION

N.T.S.



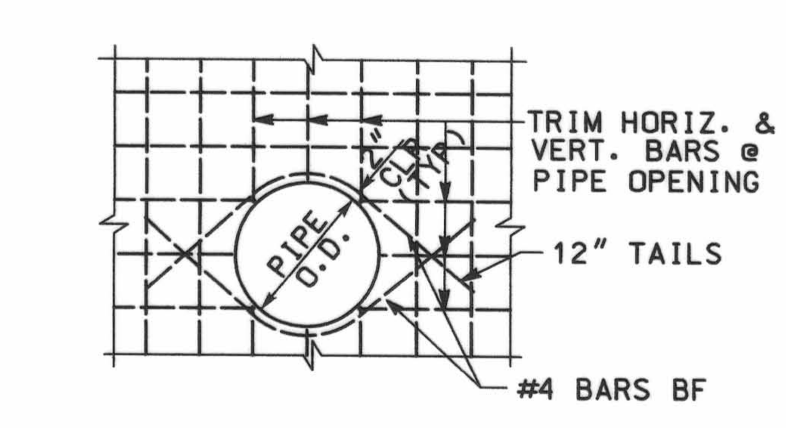
SECTION FRONT VIEW

N.T.S.



HEADWALL CORNER SECTION

N.T.S.



SECTION-PIPE OPENING

N.T.S.

AS-BUILT DRAWING

REV.	DATE	BY	DESCRIPTION

Designed THOM RUTLEDGE 12/02
Drawn THOM RUTLEDGE 12/02
Checked DAN VILLINES 12/02
Date

REGISTERED PROFESSIONAL ENGINEER KEVIN S. BRANDT No. C54873 Exp. 06/30/04 CIVIL STATE OF CALIFORNIA

PREPARED BY:
Tettemer & Associates
consulting engineers
ENGINEERING · MANAGEMENT · PLANNING
TECHNOLOGY DRIVE, IRVINE, CALIFORNIA

SCALE
AS SHOWN
Bar Scale shown below is one inch on original drawing. If NOT one inch on this sheet, adjust scales accordingly.
0" 1"

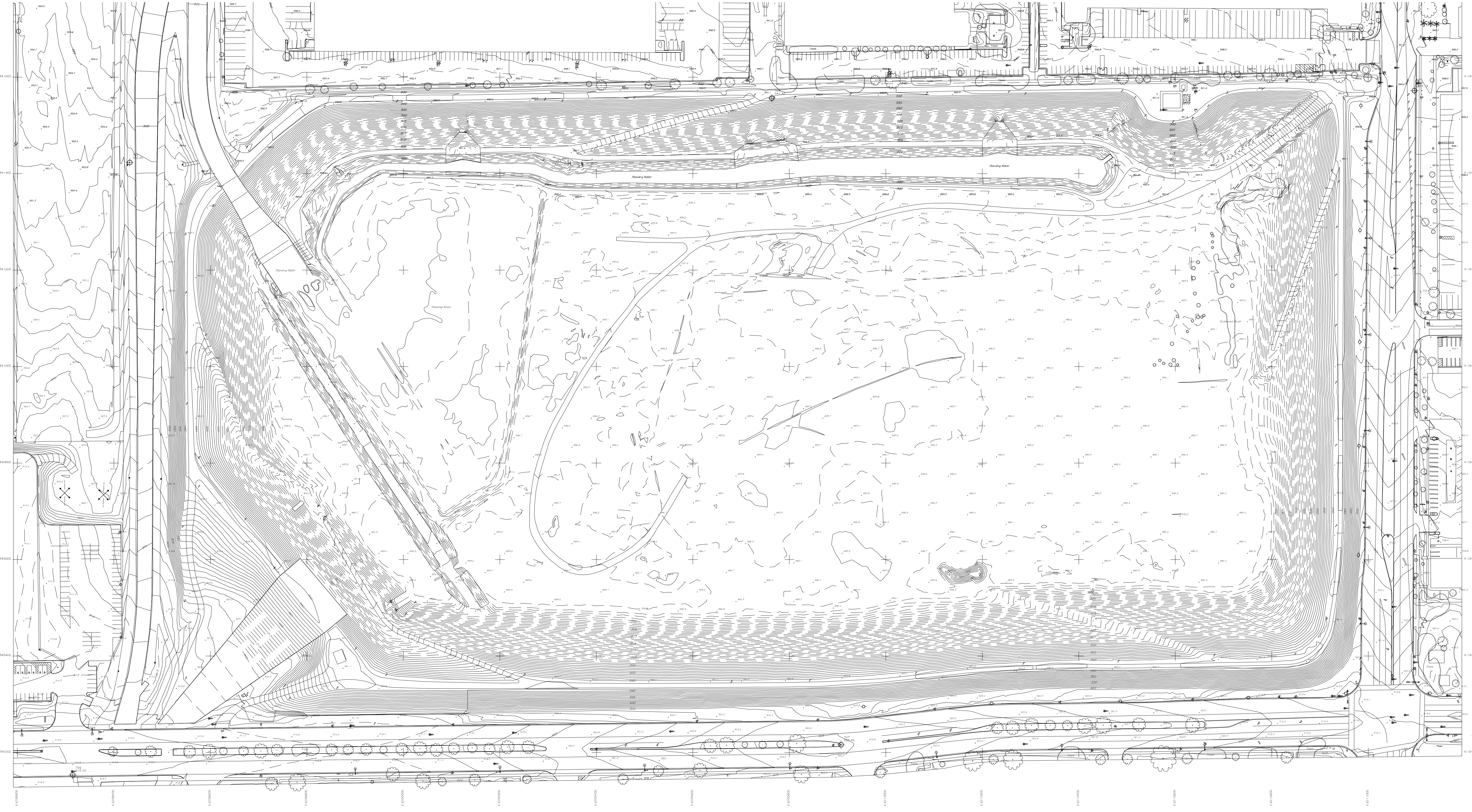
INLAND EMPIRE UTILITIES AGENCY
A Municipal Water District
LOCATION
9400 Cherry Avenue, Building A
Fontana, California 92335
Telephone (909) 357-0241
MAILING ADDRESS
Post Office Box 697
Rancho Cucamonga, California 91730

CHINO BASIN FACILITIES IMPROVEMENT PROJECT
JURUPA BASIN

INLET STRUCTURE DETAILS

SHEET S5
25 OF 27 SHTS
DWG. NUMBER D8004-027

J: 110188/DGN/JURUPA/SHTS05_JURUPA.DGN



0 100' 200'

SCALE IN FEET

AeroTech Mapping

2997D Technology Drive, Suite 220-C
Murrieta, CA 92563 · (619) 606-5020

Project: **Jurupa Basin**
Ontario, CA

Client: **Stantec**

Flight Date:
September 8, 2015

ATM #C0615-059

Map Scale 1"=40'

Plot Scale 1"=100'

Legend

AERIAL PANELS · GRID TEXT · GRID TICK · SPOT ELEVATION · CACTUS · PALM TREE · SINGLE TREE · FLAG · GATE · SIGNS · BILLBOARD · OVERHEAD SIGNS · STREET SIGN · POST / BOLLARD · FIRE HYDRANT · METER / UTILITY · MANHOLE · VALVE · CATCH BASIN · CULVERT · UTILITY POLE · TRANSMISSION · TV DISH · LIGHT POLE · TRAFFIC SIGNAL · PEDESTRIAN SIGNAL · STREET LIGHT · STRAIGHT ARROWS · DIRECTIONAL ARROWS · MINE · BIKE LANE · HANDICAP · TRAFFIC PAINT · TRAFFIC PAINT · BUILDING · SWIMMING POOL · BRIDGE · CANOPY · ROCKS · TRAFFIC LANE PAINT · PARKING STRIPES · ROAD / PAVEMENT · DIRT ROAD / TRAIL · CURB / GUTTER · CONCRETE · RAILROAD · FENCE · RETAINING WALL · GUARD RAIL · INDEX CONTOUR / TEXT · INTER CONTOUR · INDEX DEPRESSION / TEXT · INTER DEPRESSION · WASH / WATER · VEGETATION LINE · GOLF FAIRWAY · GOLF GREEN / TEE · GOLF SANDTRAP · FIELD / GRASS