A California Corporation
Specializing in Geotechnical Engineering

Hultgren-Tillis Engineers

GEOTECHNICAL INVESTIGATION

LOWER WALNUT CREEK CHANNEL
MARTINEZ / CONCORD, CALIFORNIA

Project No. 670.01
July 27, 2007

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July 27, 2007
Project No. 670.01

Contra Costa County Public Works
Flood Control & Water Conservation District
255 Glacier Drive
Martinez, California 94553

Attention: Mr. Larry Thies

Geotechnical Investigation
Lower Walnut Creek Channel Interim Protection Project
Martinez / Concord, California

Gentlemen:

We provided geotechnical engineering services for the Lower Walnut Creek Channel Interim Protection Project. We compiled the available geotechnical data along the lower Walnut Creek flood control channels. We also collected and tested soil samples of the channel sediment and from potential borrow sites. In addition, we provided geotechnical recommendations for the proposed levee raising along the Walnut Creek and Grayson Creek channels. Our scope of services, were outlined in our proposals dated April 3, 2007 and May 22, 2007. The existing data collected and the results of previously published data from our letter reports are included in this report.

It was a pleasure working on this project and we look forward to working with the County during construction. If you have any questions, please call.

Sincerely,

Hultgren – Tillis Engineers

Jerrold Hanson
Civil Engineer

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I. INTRODUCTION

This report presents the results of our geotechnical engineering services for the Lower Walnut Creek Channel Interim Protection project. We compiled the available geotechnical data along the Walnut Creek, Grayson Creek, Pacheco Creek, and Clayton Drain flood control channels. Hand Auger samples of the Walnut Creek channel sediment between Concord Avenue and Grayson Creek were collected, and laboratory testing performed to evaluate the geotechnical characteristics of the soil. Additionally, soil samples from three possible borrow sites (Central Contra Costa County Sanitary District's [Central San's] Detention Basin B, Central San's Kiewit Parcel, and Pacheco Marsh) were collected and tested to evaluate potential use as fill to raise grade on a portion the existing levees. We also performed preliminary geotechnical engineering analyses to prepare conceptual levee sections, along with geotechnical recommendations for raising the levees along Walnut Creek and Grayson Creek. Our scope of services was outlined in our proposals dated April 3, 2007 and May 22, 2007 and the results of our geotechnical engineering services are presented in this report.

II. EXISTING FIELD DATA

We gathered and assembled existing data available from previous investigations at or near the Lower Walnut Creek flood control channels. The approximate location of subsurface data is shown on the Boring Location Maps, Plates A-1 through A-4 in Appendix A. We assigned a unique reference number to each boring location shown on the maps. The Key to Boring Locations, Plates A-5 through A-8, present the boring location reference number used on the Boring Location Maps, the agency that logged the boring, the agency's boring name, date of the drilling and the approximate latitude and longitude of the boring (NAD 1983). The "borings" include both drilled borings and pushed cone penetration tests. Logs of the borings and cone penetration tests are presented after Plate A-8 in Appendix A, in order of their Boring Location reference number.

III. SEDIMENT

We collected soil samples of the sediment in the Walnut Creek Channel between Concord Avenue and the confluence of Grayson Creek. The approximate sample locations are indicated on the Sediment Sampling Location Map, Plate B-1 in Appendix B. Logs of the hand auger samples are presented on Plates B-2 through B-7 in Appendix B. The soil descriptions are presented in general accordance with the Soil Classification System presented on Plate B-8 in Appendix B.

Laboratory testing was performed to evaluate the moisture content, percentage finer than a No. 200 sieve, and Atterberg Limits. The results of the Walnut Creek Channel sediment tests are tabulated in Table 1, below. The Plasticity Index results for the Walnut Creek Channel Sediment are also plotted on Plate B-9 in Appendix B.

TABLE 1

WALNUT CREEK CHANNEL

Sample No.	Description	Depth	Moisture Content (%)	#200 Sieve (% Passing)	Liquid Limit	Plasticity Index
1	Sandy Lean Clay (CL)	1.5 - 2.0	22	59	33	11
2a	Silty Sand (SM)	1.5 - 2.0	34	49	39	12
2b	Sandy Lean Clay (CL)	2.0 - 2.5	42	68	47	25
3	Sandy Silt (ML)	1.5 - 2.0	12	51	31	5
4a	Lean Clay w Sand (CH)	1.5 - 2.0	33	78	49	29
4b	Fat Clay w Sand (CH)	2.0 - 2.5	43	87	75	49
5	Sandy Clay (CL-CH)	1.5 - 2.0	18	59	50	31
6	Silty Sand (SM)	1.5 - 2.0	20	30	Non-Plastic	Non-Plastic

The sediment soil type in the Walnut Creek Channel is variable. Soils that classify as clay could be used for fill to raise the levees. However, it should be noted that the moisture contents of the samples below a depth of about 2 feet are very high. Material with high moisture content would need to be processed (air drying, mixing with drier material, etc.) to reduce the moisture content, if the material is to be used for compacted fill. An efficient approach to drying the wet material can be disking the material in the borrow area until a moisture content that is suitable for compaction is achieved. Then, after the processing is completed, the sediment can be hauled to the levee site where the material will be placed as fill.

IV. FILL BORROW SITE TEST RESULTS

We evaluated potential fill materials from several borrow sites being considered as sources for new levee fill. Our evaluation included three sites: Central San's Detention Basin B, Central San's Kiewit Parcel, and Pacheco Marsh. These three sites are in the general vicinity of the levees that may be raised. Central San's Detention Basin B is located south of the BNSF Railroad crossing on the west side of Walnut Creek. The Kiewit Parcel is located north of Highway 4 between Walnut Creek and Grayson Creek. The location of Detention Basin B and the Kiewit Parcel are shown on Plate C-1 in Appendix C. The location of the Pacheco Marsh site is shown on Plate C-2. Pacheco Marsh is located west of Walnut Creek between Waterfront Road and Suisun Bay.

We collected near surface soil samples on April 30, 2007 from 20 five-foot deep borings. The borings were drilled with truck-mounted, auger drill equipment. Samples were collected with a 2.5-inch outside diameter sampler using liners. The samplers were driven with a 140-pound hammer falling approximately 30 inches for a penetration depth of 18 inches. The hammer utilized a rope-and-pulley system. The shallow borings were backfilled with cuttings from the drilling. The approximate boring locations are shown on the Borrow Site Boring Location Maps, Plates C-1 and C-2 in Appendix C.

Our engineer observed and logged the borings and collected samples for further examination and laboratory testing of selected samples. Soil descriptions and equivalent Standard Penetration Test results are presented on the Logs of the Borings, Plates C-3 through C-22 in Appendix C. The field blow counts measured using the 2.5-inch outside diameter sampler were corrected to approximate Standard Penetration Test N-values by multiplying by 0.8 for presentation on the boring logs. The soil descriptions are presented in general accordance with the Soil Classification System presented on Plate C-23 in Appendix C.

Laboratory testing was performed to evaluate the moisture content, percent passing the No. 200 sieve, and Atterberg Limits. The laboratory test results are noted on the logs of borings at the depth of the sample. Summaries of the laboratory test results for each site are tabulated in following tables (Tables 2, 3, and 4). The Atterberg Limit results for each site are also plotted on Plates C-24, C-25, and C-26 in Appendix C.

A. Detention Basin B

TABLE 2

CENTRAL SAN'S DETENTION BASIN B						
Boring No.	**Description**	**Depth**	**Moisture Content (%)**	**% Passing No. 200 Sieve**	**Liquid Limit**	**Plasticity Index**
1	Lean Clay with Sand (CL)	1.5 - 2.0	27	71	47	27
2	Sandy Lean Clay (CL)	1.5 - 2.0	13	67	37	19
3	Fat Clay with Sand (CH)	1.5 - 2.0	31	97	51	25
5	Lean Clay with Sand (CL)	1.5 - 2.0	24	77	48	27
6	Sandy Lean Clay (CL)	1.5 - 2.0	20	65	40	21

The near surface soil samples from the Central San's Detention Basin B classify as clay and are suitable to be used as fill to raise the levees, except Boring 4 where poorly-graded sand was encountered approximately 18-inches below the ground surface. Laboratory testing was performed to classify samples 1½ to 2 feet below the ground surface, except for Boring 4 which was visually classified as sand. The moisture contents of the samples, except the sample from Boring 2, are significantly over optimum moisture. We anticipate the moisture content will increase with depth. Material with high moisture content would need to be processed (air drying, mixing with drier material, etc.) to reduce the amount of water, if the material is to be used for compacted fill. An efficient approach to drying the wet material could be disking the material in the borrow area and then hauling it to the levee site when the moisture content is suitable for compaction.

B. Kiewit Parcel

TABLE 3

CENTRAL SAN'S KIEWIT PARCEL						
Boring No.	**Description**	**Depth**	**Moisture Content (%)**	**% Passing No. 200 Sieve**	**Liquid Limit**	**Plasticity Index**
7	Silty Sand (ML)	2.0 - 2.5	23	33	38	10
8	Sandy Lean Clay (CL)	4.0 - 4.5	16	60	45	24
9	Sandy Silt (ML)	4.5 - 5.0	17	56	45	17
10	Clayey Sand (SC)	2.0 - 2.5	17	41	52	32
11	Clayey Sand (SC)	2.0 - 2.5	19	49	41	17
12	Clayey Sand (SC))	6.0 - 6.5	30	49	52	24

Four of the six near surface soil samples from the Kiewit Parcel classify as sand, one sample classifies as a silt, and one sample classifies as clay. The samples have more than 40 percent passing the No. 200 sieve, except the sample from Boring 7, which has 33 percent. In general, the upper five feet of soil on the Kiewit parcel have a high percentage of clay or actually classify as clay based on the percent passing No. 200 sieve and Atterberg Limit results. In our opinion, most of these materials are suitable to raise the nearby levees. Some selective borrowing may be needed to avoid silty sand and other non-plastic or low plasticity soils.

C. Pacheco Marsh

TABLE 4

PACHECO MARSH						
Boring No.	**Description**	**Depth**	**Moisture Content (%)**	**% Passing No. 200 Sieve**	**Liquid Limit**	**Plasticity Index**
13	Silty Sand (SM)	4.0 - 4.5	36	43	33	6
14	Poorly Graded Sand with Silt/Clay (SP-SM/SC)	1.5 - 2.0	44	7	59	29
14	Sandy Lean Clay (CL)	4.0 - 4.5	39	67	44	19
15	Silty Sand (SM)	2.0 - 2.5	54	45	58	26
16	Elastic Silt (MH)	2.0 - 2.5	45	88	67	33
17	Elastic Silt (MH)/Fat Clay (CH)	2.0 - 2.5	46	88	53	24
18	Elastic Silt with Sand (MH)	2.0 - 2.5	51	83	66	29
18	Elastic Silt with Sand (MH)	4.0 - 4.5	39	82	55	20
19	Poorly Graded Sand with Clay (SP-SC)	2.0 - 2.5	19	9	53	27
19	Fat Clay (CH)	4.0 - 4.5	22	92	59	33
20	Sandy Elastic Silt (MH)	3.5 - 4.0	35	59	67	31

The near surface soil samples from Pacheco Marsh classify as silt, sand, and clay. Most of the samples have plasticity indices greater than 18. Samples from the northern portion of the Pacheco Marsh site have moisture contents that greatly exceed the optimum moisture content. We do not believe that it would be practical to try to use these very wet materials for fill. The samples from the southern portion of the Pacheco Marsh site have high moisture contents also, but in the range where conditioning the material may be more practical. The materials would need to be processed (air drying, mixing with drier material, etc.) to reduce the moisture content, if the material is to be used for compacted fill. Overall, we conclude that these materials are not as well suited for levee fill as clays from other borrow sites.

V. WALNUT CREEK AND GRAYSON CREEK LEVEE RAISING

Several reaches of the existing levees along Walnut Creek and Grayson Creek channels will be raised.

- Reach 1 - The west side of the Walnut Creek Channel from the BNSF railroad crossing to Grayson Creek
- Reach 2 - The west side of the Grayson Creek Channel from the confluence with Walnut Creek to Highway 4
- Reach 3 - The east side of Grayson Creek from Highway 4 to Interstate 680, and
- Reach 4 - The north side Clayton Drain levee from Walnut Creek to Hillcrest Community Park
- Area 5 – Bridge abutment/levee transitions where Marsh Road crosses Walnut Creek Channel, on the upstream and downstream sides of the bridge (east and west sides).

The approximate locations of reaches and areas to be improved are shown on the Site Plan, Plate 1.

A. Levee Geometry

Depending on the amount of fill and the existing conditions, the width of the levee crest will vary. In some locations, it is possible to maintain or augment the top width of the levee if new fill is placed on the adjacent property or by building a low retaining wall. We prepared conceptual cross sections to illustrate possible alternatives, Plates 2 through 7. The approximate locations of the cross sections are indicated on Plate 1. We assumed two feet of new fill as the maximum for the cross sections. If one foot of fill is placed, then the assumed section can be lowered and shifted laterally to build the desired width.

The typical Army Corps design for these levees had a levee top width of 18 feet, with a 3:1 (horizontal to vertical) channel side slope and a 2:1 landside side slope. It appears that subsequent fill placement has created a 2:1 channel side slope near the top of the levee in many locations. In our opinion, the upper portion of the levee can be 2:1 provided the new fill is overbuilt and trimmed to expose compacted fill on the levee slope. The conceptual cross sections all assume the new fill side slopes are inclined at 2:1.

Assuming up to two feet of fill may be placed on the levee crest, we checked whether an 18-feet wide levee crest would fit within the physical bounds of the existing levee geometry. These bounds included assuming that: (1) the existing channel-side slope would not be steepened, (2) new fill would not extend past existing fences, and (3) new fill would not be positioned to add load to an existing retaining wall along Reach 3. We also laid out the catch points for a 21 feet wide crest. These fill prisms are shown on the cross-sections, Plates 3 through 8. We found that a new 18 feet wide crest two feet above the existing crest could be constructed at three of the five sections. At Station 147+00 on Reach 1, the crest would be limited to 17.5 feet.

B. Reach 3 Existing Retaining Wall

A mobile home park abuts Reach 3. An existing 3 to 4 feet high retaining wall bounds the landside edge of the levee in this area, forming the boundary of the levee and the backyards of the adjoining mobile home park. At Station 43+00 on Reach 3, a two-feet higher crest could only be 15 feet wide without significantly surcharging the existing retaining wall (Plate 6). Levee crest raising in this area will need to be setback from the back of the wall or a new wall (Plate 7) should be built behind the existing wall. From our visual reconnaissance, the retaining wall appears to encroach on the levee's design cross-section. The County may wish to check property lines to see if the wall is encroaching on the levee. This wall condition is common along Reach 3

C. Marsh Road Bridge at Walnut Creek

The location where Marsh Road bridge crosses Walnut Creek will need special attention. The levee crests on the south side of the bridge (east and west) will need to be raised. Electrical power and telecommunication conduits are attached to the upstream (south) side of Marsh Road bridge. Near the bridge abutments, on both sides of Walnut Creek, the conduits turn into the ground and connect to vaults. It may not be feasible to place new fill in a low area between the levees and bridge abutments without reconfiguring the existing underground utility vaults. As an alternative, a low masonry or concrete flood wall could be built between the bridge abutment and the new levee fill to provide continuity for flood control protection across the buried conduits. The existing trench backfill will need to be hand excavated in the foundation area for the new flood wall and backfilled with concrete or flowable fill. It appears that the levees on the north side of the bridge can be raised with new fill, following normal embankment construction procedures.

D. Existing Trees

Trees are growing in the levee section or immediately adjacent to the levee section at several locations. The most concentrated zone of trees are those along Reach 3, adjacent to the mobile home park. Trees within the existing levee section along Reach 3 are the greatest concern. Trees also were noted at the south end of Reach 2 adjacent to Central San's facility. A lone tree occurs south of the Marsh Road bridge east abutment.

Trees can adversely affect levee performance and existing trees and shrubs should be removed from the levee section, along with the underlying root mass. Tree removal will undoubtedly be unwelcomed by the mobile home residents, Central San, and others. It will be important to effectively communicate the risk of levee failure if the trees (including the root mass) are not removed from the levee embankments.

E. Levee Stability

We performed engineering analyses to evaluate the global stability where new fill is placed in what we judged to be critical levee sections, where the underlying weak Bay Mud deposits are the thickest at the northern end of Reach 1. We characterized the subsurface soils by assuming that they are normally consolidated, or nearly normally consolidated, under existing loads. We assumed two feet of additional fill would be placed on the levee crest for our analyses. Our analyses indicate that the immediately-after-construction factor of safety would be greater than 1.5.

F. Earthwork Recommendations

The material quality requirements for the levee embankment should reflect, in part, the importance or value of the properties protected by the levee. Upstream (south) of the BNSF Railroad bridge, we recommend that moderate plasticity lean clays or clayey sands be used to raise the levee. We recommend that the clays classify as a CL in accordance with ASTM D 2484 and that the clays have a plasticity index equal or greater than 18. Clayey sands are also suitable provided they classify as SC per ASTM D 2487, have at least 30 percent passing the No. 200 sieve, and have a plasticity index equal or greater than 18.

New embankment fill placed at the site should be a soil or soil/rock mixture free of deleterious or organic matter and contain less than 15 percent rocks or hard fragments. Rocks or hard fragments should be less than 4 inches in maximum dimension. The clay fill should have a minimum plasticity index of 18. Clay soil from the channel sediment removal that is free of debris and organic matter may be used as new embankment fill.

1. Gravel Reuse

Prior to fill placement, the existing top-of-levee ground surface should be prepared by removing the existing gravel, and then processing and recompacting the exposed materials. The gravel should be removed in a way that limits mixing with underlying silts and clays. The upper portion of the gravel that has not been mixed with silts and clays should be excavated and stockpiled for later use to cap the new fill. The lower portion of the gravel, nominally about 1 to 2 inches thick that has a high percentage of silt and clay, can be processed in place by thoroughly discing the gravel into the underlying fine grain soils (silts and clays). The resulting gravel/clay/silt mix should consist of more than 50 percent material passing through the No. 200 sieve.

Initially several small excavations (potholing) should be made to evaluate the gravel thickness as well as evaluate where the gravel with a high percentage of clay and silt begins. Then, based on the pothole observations, estimates can be made regarding the amount of gravel that can be removed and stockpiled for later use to build an all weather surface on the raised levee crest.

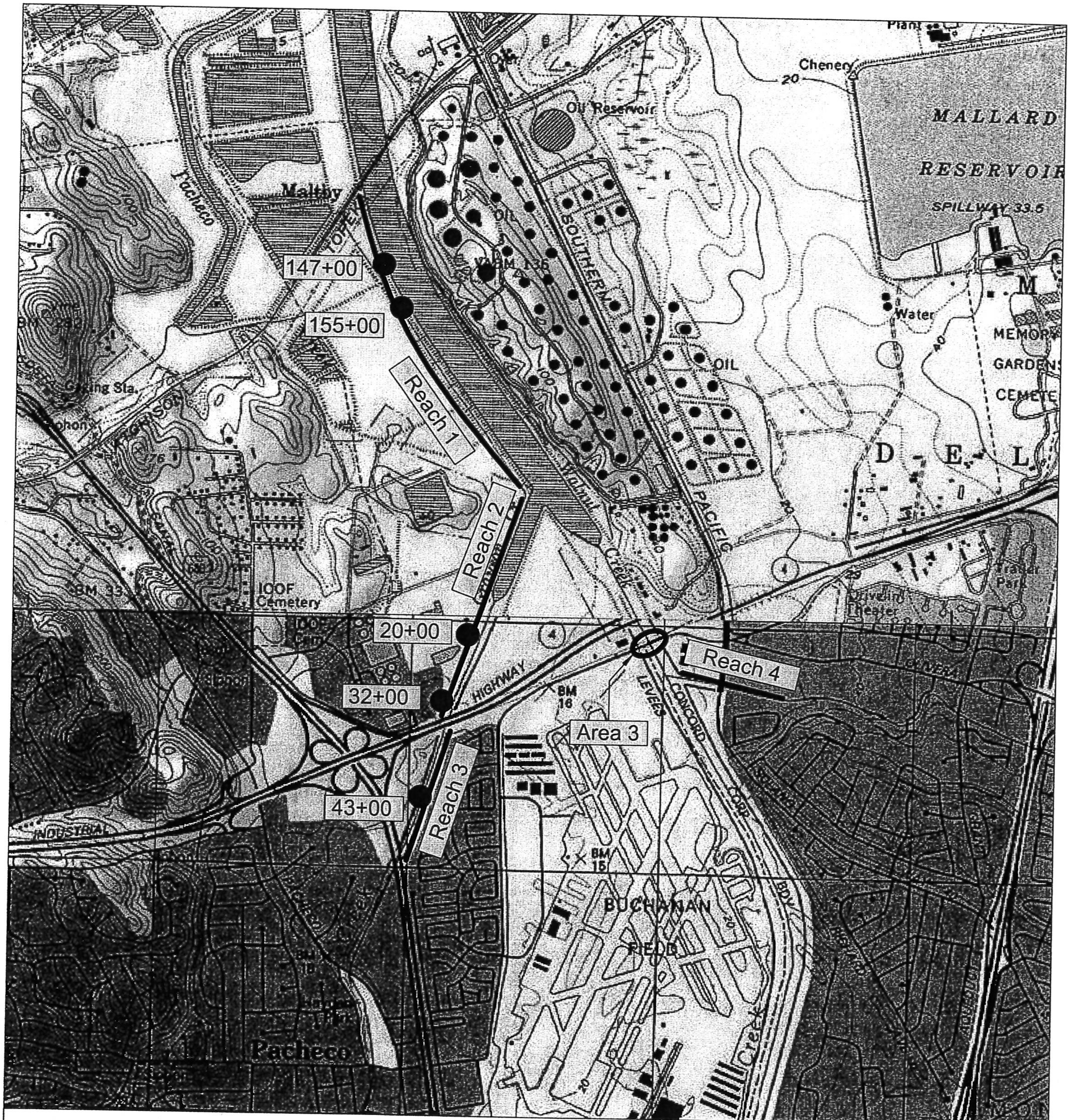
2. Site Preparation and Grading

Vegetation within the area to be filled should be stripped to sufficient depth to remove the vegetation as well as soil containing roots. Trees, shrubs, and stripped material should be off-hauled to a suitable disposal area. If loose or soft materials are encountered during the vegetation removal, the materials should be over-excavated to expose firm soil and rebuilt with compacted fill.

Ground surfaces exposed by stripping or excavation should be scarified to a depth of at least 8 inches or the full depth of shrinkage cracks. The scarified soil should be moisture conditioned to at least 3 percent over optimum moisture content and compacted to at least 90 percent relative compaction. ASTM test D-1557 (latest edition) should be used to establish the reference values for optimum moisture content and maximum dry density.

New embankment fill should be placed in lifts 8 inches or less in loose thickness and moisture conditioned to at least 3 percent over optimum for common fill. Moisture conditioning should be performed prior to compaction. Each lift should be methodically compacted to at least 90 percent relative compaction. Reused gravel or Class 2 aggregate base rock should be used to cap the level crest and to create an all-weather road. Aggregate materials for levee crest capping should be compacted to at least 95 percent relative compaction.

A sheepsfoot compactor, smooth drum roller or other equivalent equipment should be used for compacting the gravel. Material that fails to meet the moisture or compaction criteria should be loosened by ripping or scarifying, moisture conditioned, and then recompacted. If soft or yielding soils are present during subgrade preparation or fill compaction, they should be air-dried and compacted or removed by excavating to expose firm soil and rebuilt with suitable materials.



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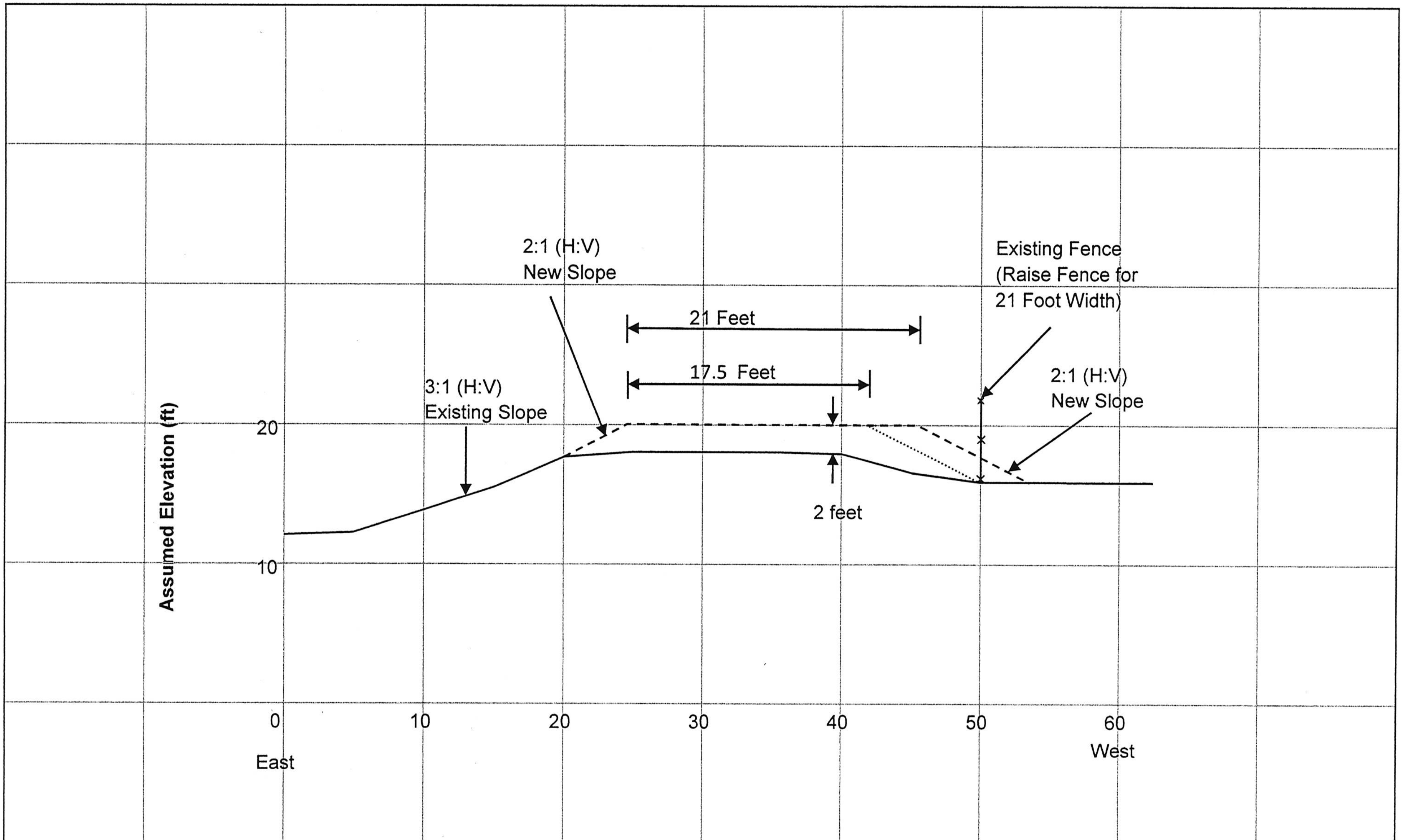
● Approximate Location of Cross Sections (Station Number)

Lower Walnut Creek Interim Protection Project Contra Costa County Flood Control Concord / Martinez, California	**Site Plan**	
Hultgren - Tillis Engineers	Project No. 670.01	Plate No. 1



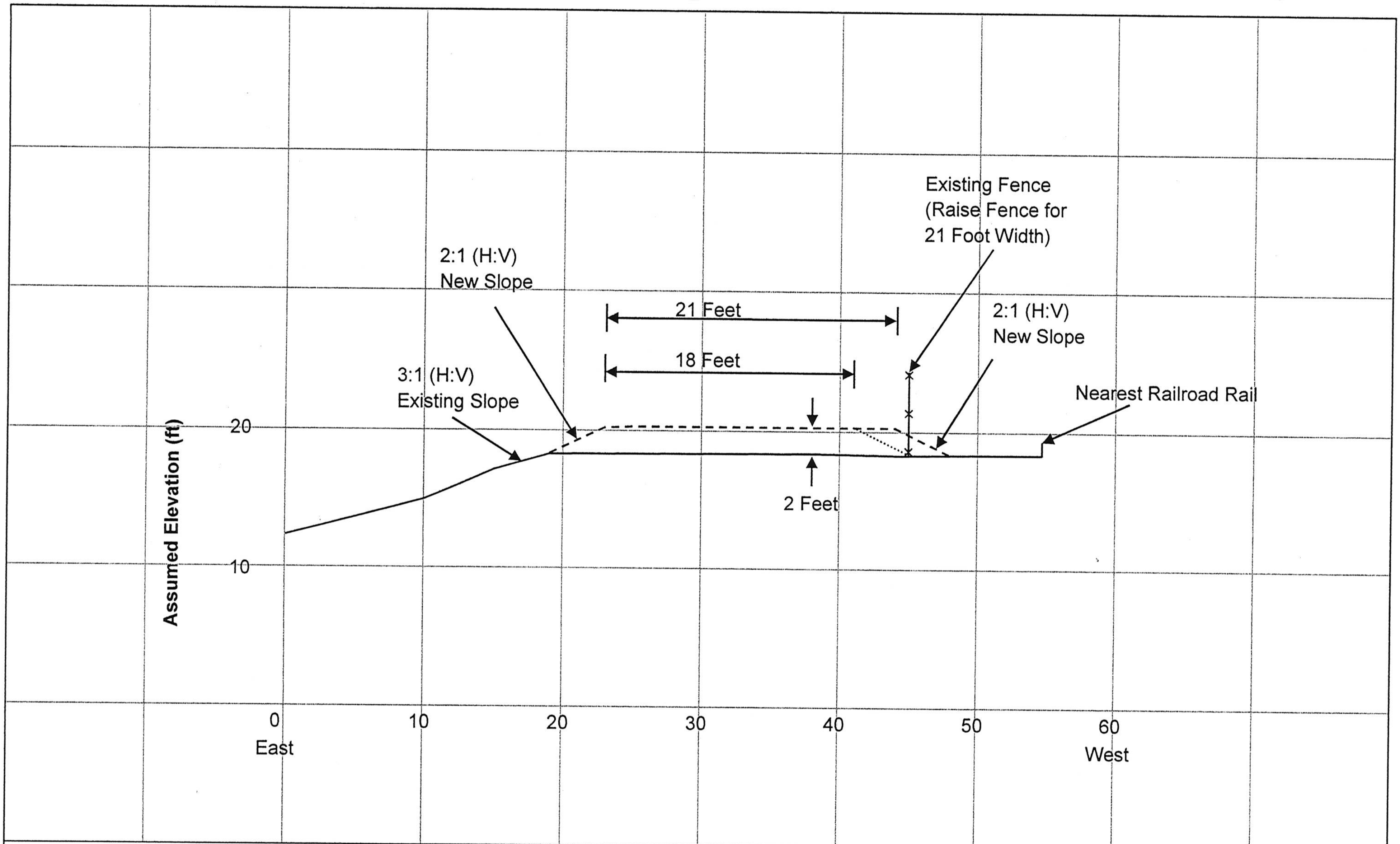
Lower Walnut Creek Channel Interim Protection
Contra Costa County Flood Control
Concord / Martinez, California

West Side Cross Section
Walnut Creek Channel 147+00

Hultgren – Tillis Engineers

Project No. 670.01

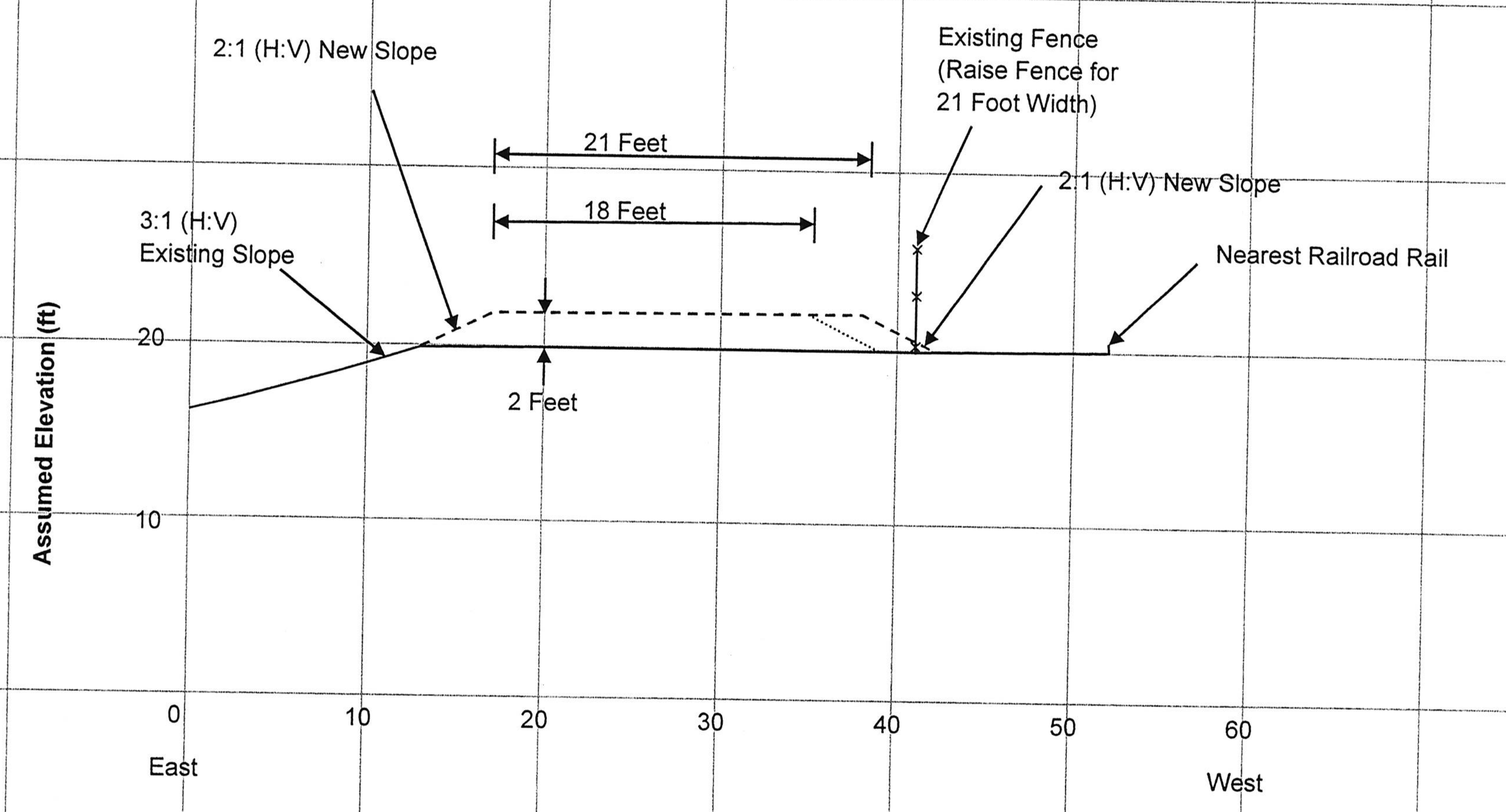
Plate No. 2



Lower Walnut Creek Channel Interim Protection
Contra Costa County Flood Control
Concord / Martinez, California

West Side Cross Section
Walnut Creek Channel 155+00

Hultgren – Tillis Engineers	Project No. 670.01	Plate No. 3



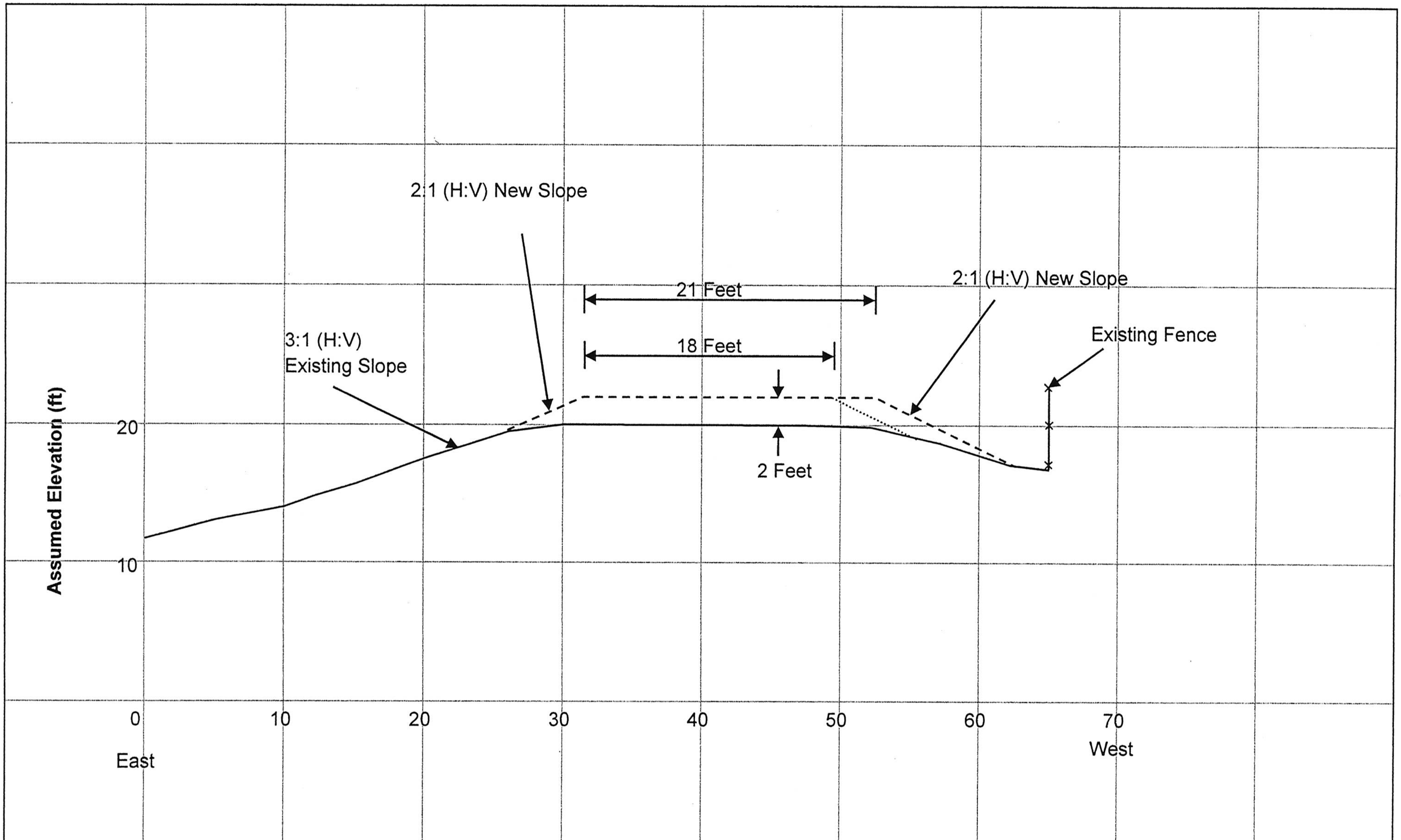
Lower Walnut Creek Channel Interim Protection
Contra Costa County Flood Control
Concord / Martinez, California

West Side Cross Section
Grayson Creek 20+00

Hultgren – Tillis Engineers

Project No. 670.01

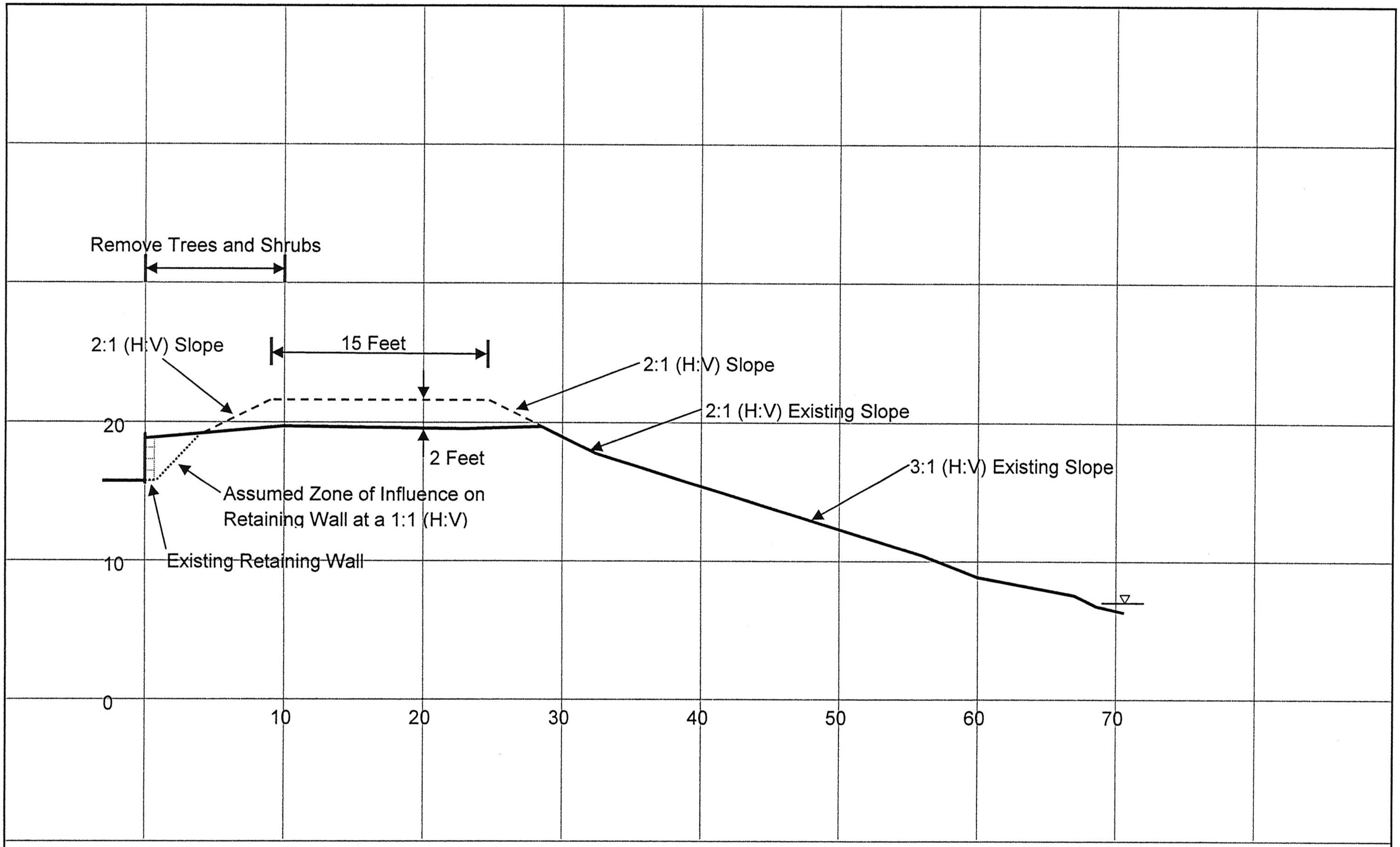
Plate No. 4



Lower Walnut Creek Channel Interim Protection
Contra Costa County Flood Control
Concord / Martinez, California

West Side Cross Section
Grayson Creek 32+00

Hultgren – Tillis Engineers	Project No. 670.01	Plate No. 5

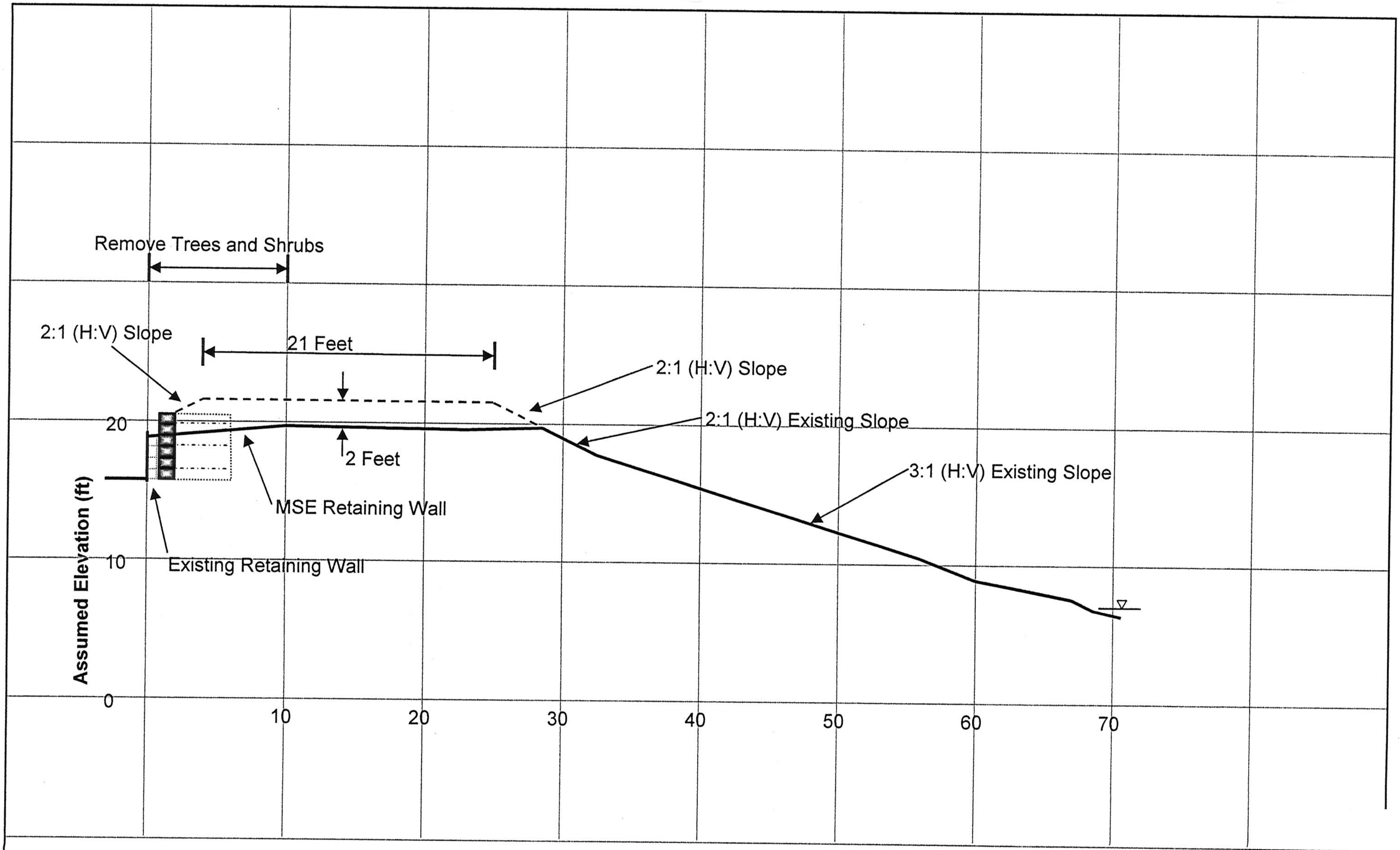


Lower Walnut Creek Channel Interim Protection
Contra Costa County Flood Control
Concord/Martinez. California

East Side Cross Section (15 Foot Width)

Grayson Creek Channel Station 43+00

Hultgren – Tillis Engineers	Project No. 670.01	Plate No. 6

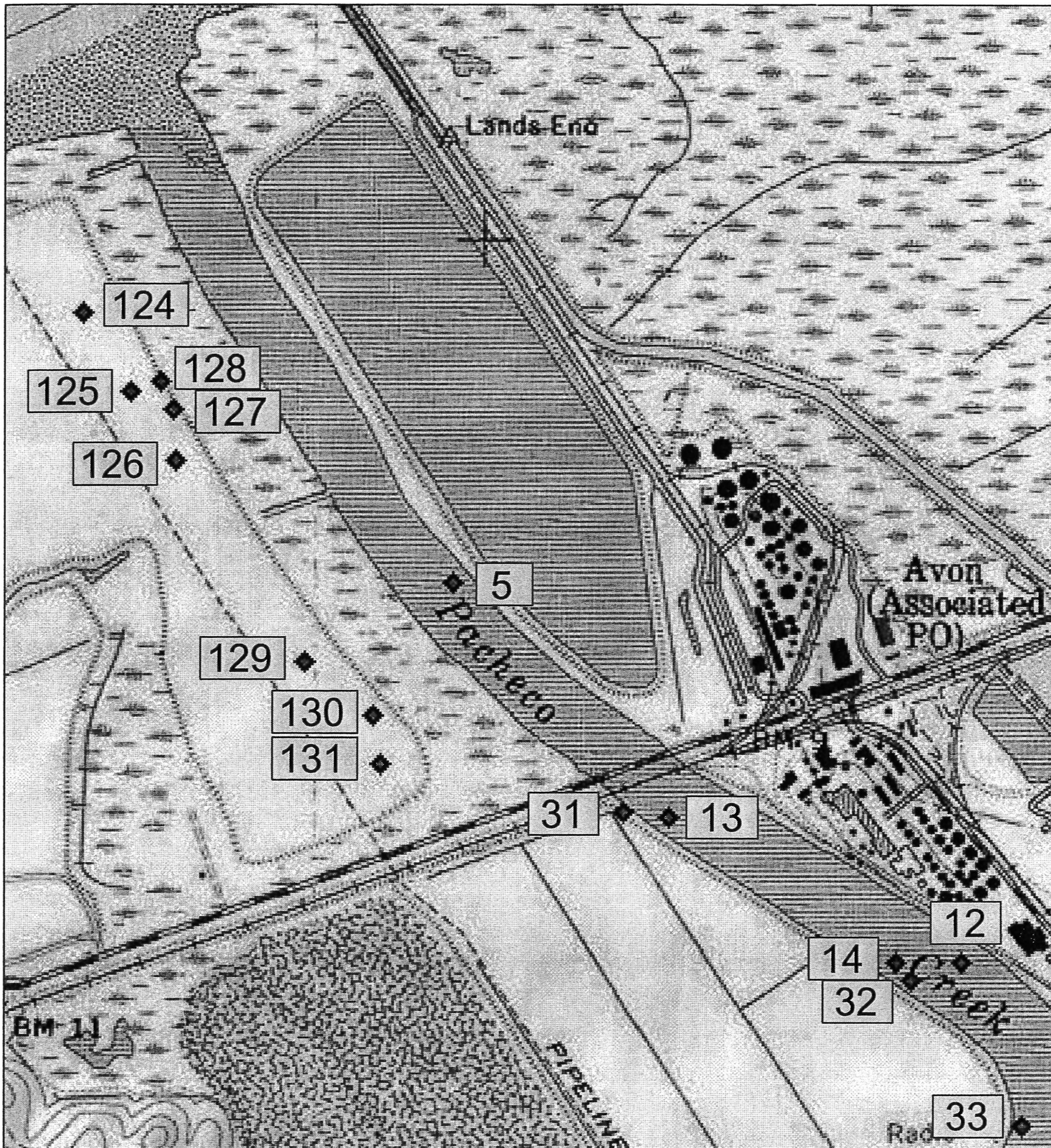


Lower Walnut Creek Channel Interim Protection
Contra Costa County Flood Control
Concord/Martinez. California

East Side Cross Section (21 Foot Width)

Grayson Creek Channel Station 43+00

Hultgren – Tillis Engineers	Project No. 670.01	Plate No. 7



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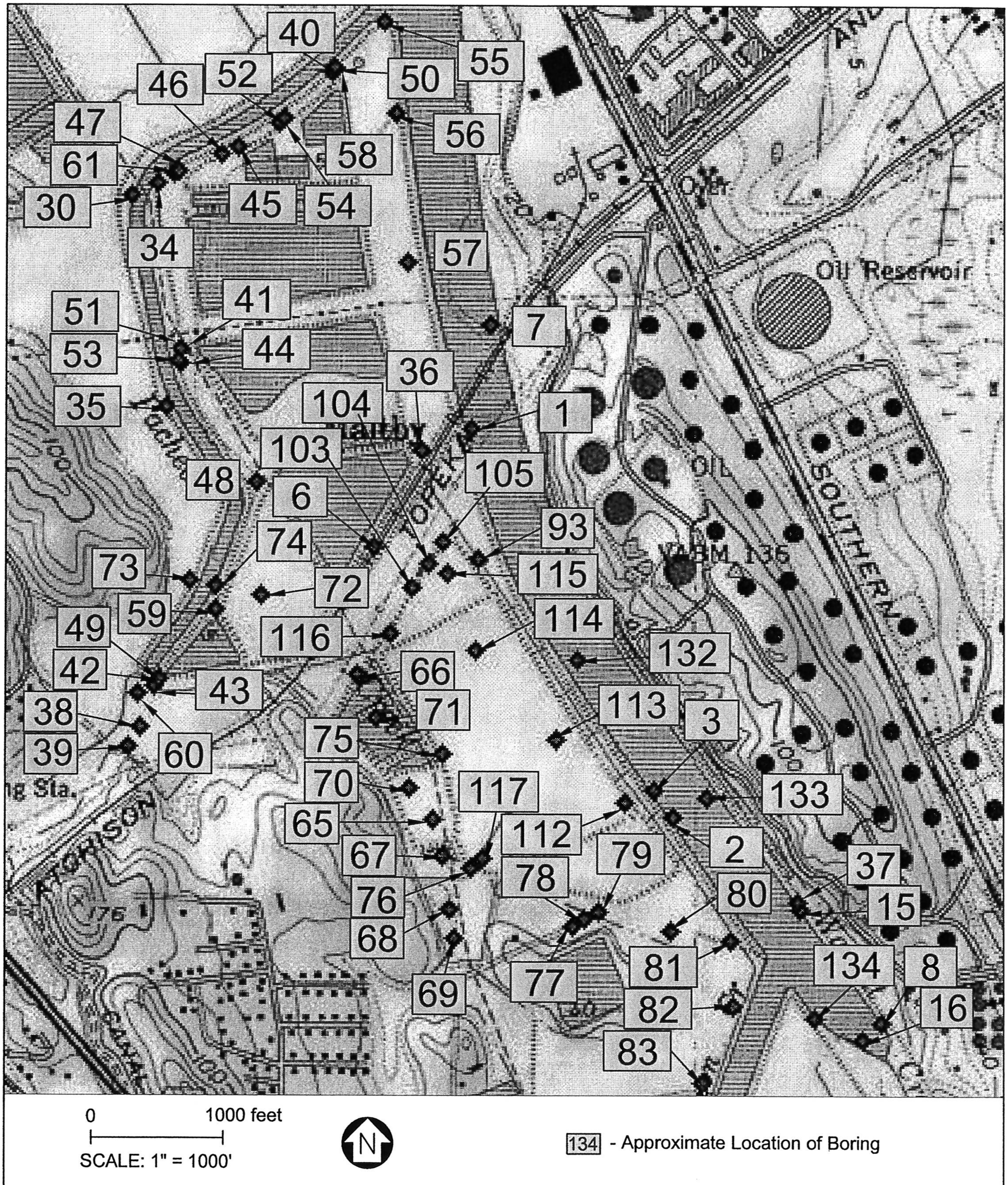
134 - Approximate Location of Boring

Contra Costa County Flood Control *Lower Walnut Creek Channel* *Martinez / Concord, California*	**Boring Location Map 1**

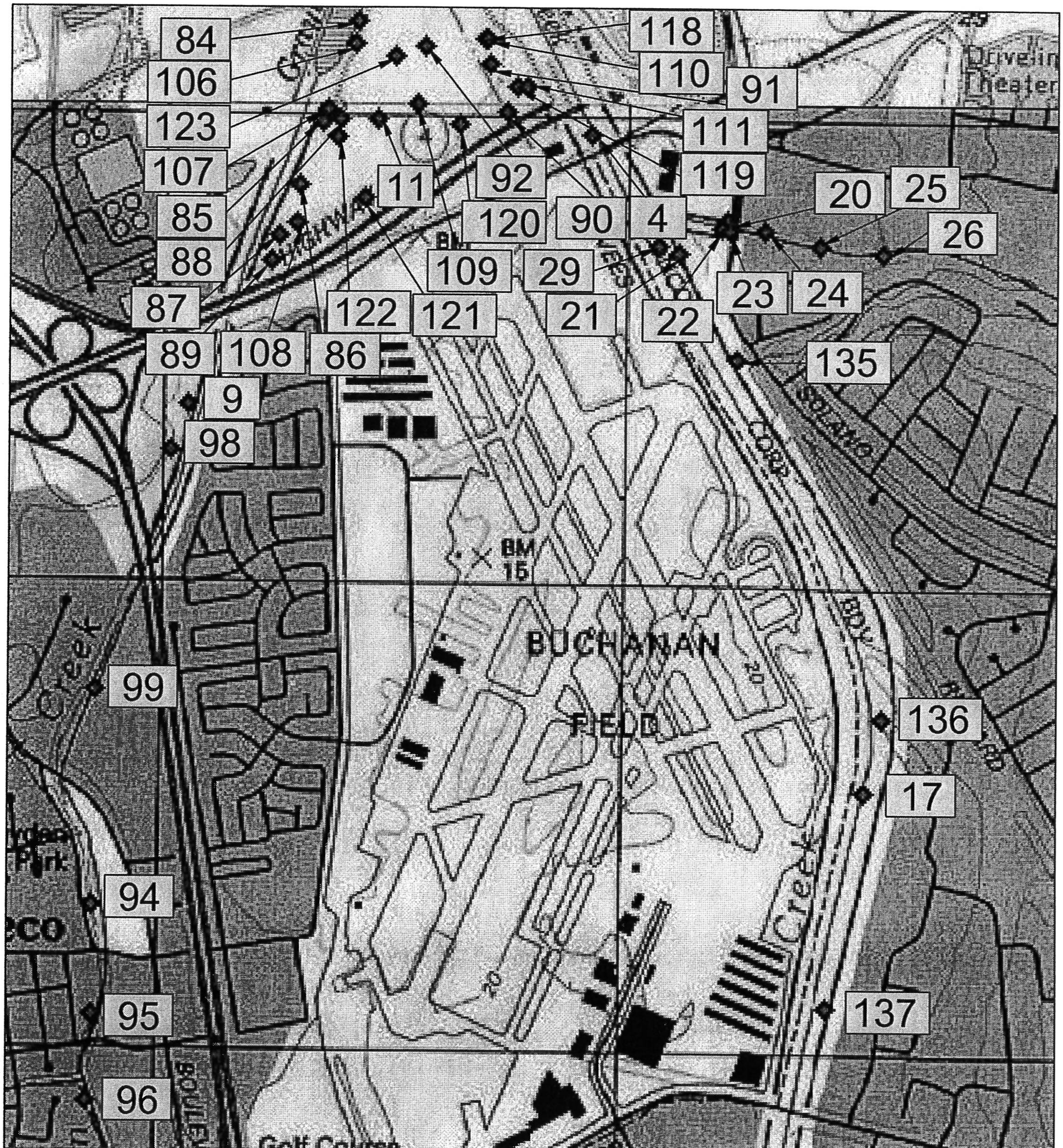
Hultgren - Tillis Engineers	Project No. 670.01	Plate No. A-1



Contra Costa County Flood Control
Lower Walnut Creek Channel
Martinez / Concord, California

Boring Location Map 2

Hultgren - Tillis Engineers	Project No. 670.01	Plate No. A-2



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SCALE: 1" = 1000'

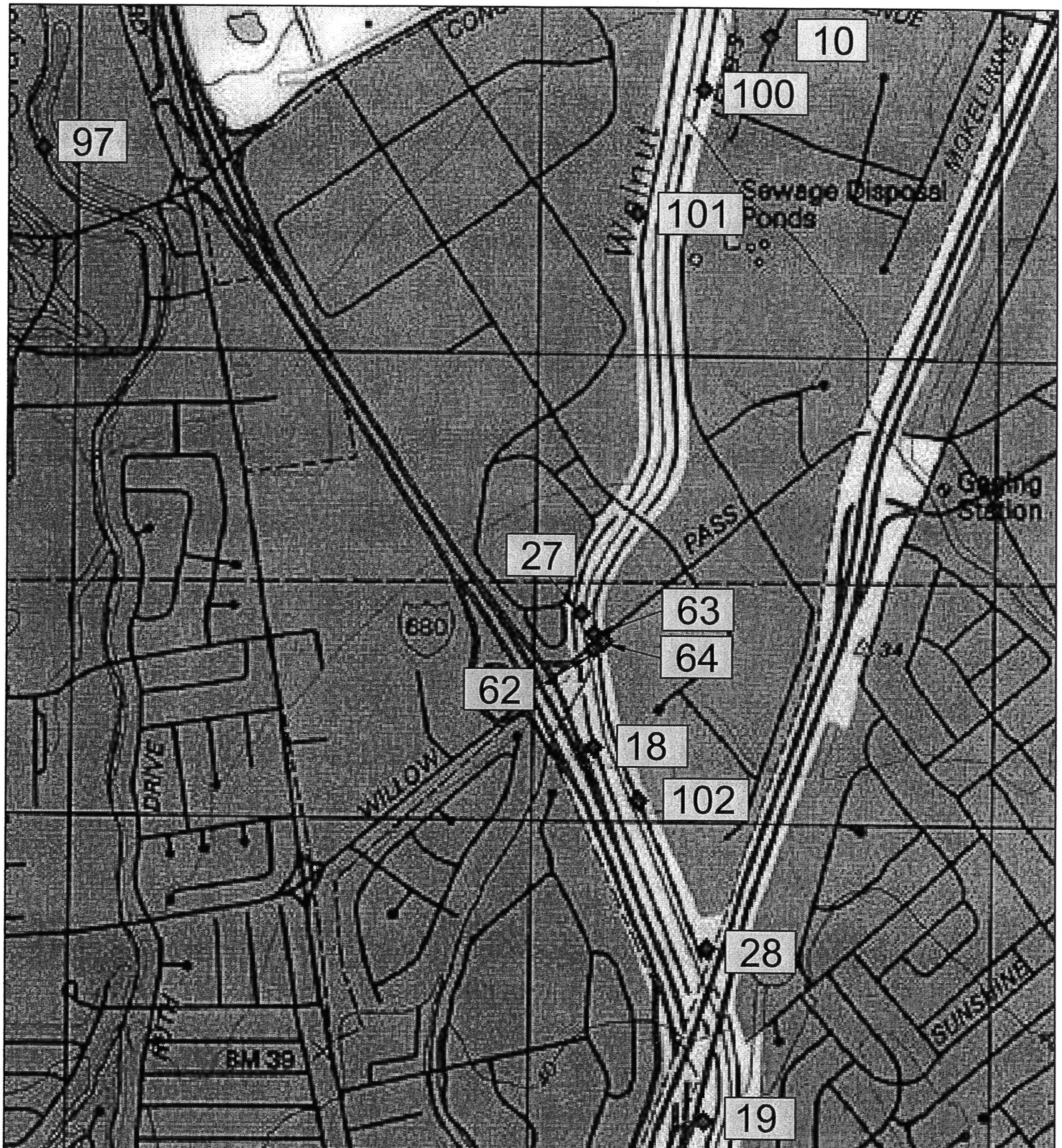
N

134 - Approximate Location of Boring

Contra Costa County Flood Control
Lower Walnut Creek Channel
Martinez / Concord, California

Boring Location Map 3

Hultgren - Tillis Engineers	Project No. 670.01	Plate No. A-3



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SCALE: 1" = 1000'

134 - Approximate Location of Boring

Contra Costa County Flood Control
Lower Walnut Creek Channel
Martinez / Concord, California

Boring Location Map 4

Hultgren - Tillis Engineers	Project No. 670.01	Plate No. A-4