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January 7, 2020

Enlarged Rollins Reservoir Concepts Opinion of Probable Construction Costs - Draft

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January 7, 2020

Nevada Irrigation District
1036 W. Main Street
Grass Valley, CA 95945

Attention: Mr. Doug Roderick, P.E.

Subject: **Enlarged Rollins Reservoir Concepts – Opinion of Probable Construction Costs Draft**

Dear Mr. Roderick:

We are very pleased to submit this Technical Memorandum (TM) documenting the Opinion of Probable Construction Costs (OPCC's) for the Enlarged Rollins Reservoir Concepts. The work described in this TM was authorized by the Nevada Irrigation District (NID) under Task Order 12 executed on October 29, 2019.

This TM was prepared to support NID's planning efforts for water supply and presents OPCC's for the following enlarged Rollins Reservoir concepts:

- Raise Rollins Embankment Dam to store an additional 50,000 acre-feet.
- Roller Compacted Concrete (RCC) Dam, downstream location – RCC Dam Concept 1, to store an additional 80,000 acre-feet. This concept would make use of the existing dam as a cofferdam during RCC dam construction.
- RCC Dam, existing dam location – RCC Dam Concept 2 to store an additional 76,000 acre-feet. This concept would involve emptying the reservoir and diverting flows around the RCC dam construction site and removing the existing embankment dam, the shell zones of which could be processed to provide RCC aggregate.

This TM discusses the following:

- RCC dam Concepts 1 and 2 and the raised embankment dam concept including foundation treatment, spillway, outlet works and diversion facilities, required construction materials, and conceptual construction site layouts.
- Construction sequencing and durations for each concept.
- The basis for and the results of the OPCC's for each concept.
- Conclusions of our work.

We are available to meet to discuss this technical memorandum with you. Please contact me at (510) 874-3012 if you have any questions.

Sincerely,
AECOM Technical Services, Inc.

M.P. Forrest

M.P. Forrest, P.E., G.E.
Project Manager

Enclosure:
Enlarged Rollins Reservoir Concepts – Opinion of Probable Construction Costs - Draft

Cc: Ted Feldsher (AECOM)

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List of Acronyms and Abbreviations

AACE	Association for the Advancement of Cost Engineering
ADAS	automated data acquisition system
cy	cubic yards
DSOD	California Division of Safety of Dams
FERC	Federal Energy Regulatory Commission
G&A	general and administrative
GE-RCC	grout-enriched roller compacted concrete (facing)
lbs	pounds
lf	lineal feet
NID	Nevada Irrigation District
OPCC	opinion on probable construction cost
RCC	roller compacted concrete
SCADA	supervisory control and data acquisition
STID	Supporting Technical Information Document
sy	square yards
TM	Technical Memorandum
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation

1 Introduction

1.1 Background and Purpose

The Nevada Irrigation District (NID) is identifying and evaluating potential water supply project concepts for consideration and analysis in its environmental review process. This Technical Memorandum (TM) presents opinions of probable construction costs (OPCC's) for the following enlarged Rollins Reservoir concepts:

- Raise Rollins Embankment Dam to store an additional 50,000 acre-feet. This concept for raising the existing embankment dam was prepared in February 2018 (AECOM 2018a) to provide information for environmental support.
- Roller Compacted Concrete (RCC) Dam, downstream location – RCC Dam Concept 1, to store an additional 80,000 acre-feet (draft TM, AECOM 2018b). This concept would keep the existing reservoir in service during construction and make use of the existing dam as a cofferdam so that downstream construction could proceed.
- RCC Dam, existing dam location – RCC Dam Concept 2 to store an additional 76,000 acre-feet (draft TM, AECOM 2019). This concept would involve emptying the reservoir and diverting flows around the RCC dam construction site and removing the existing embankment dam, the shell zones of which could be processed to provide RCC aggregate.

These concepts are compared in Table 1, Rollins Dam and Reservoir, Concepts Comparison Matrix. The Rollins Reservoir Site Vicinity Map is shown in Figure 1.

The work described in this TM was authorized by NID under Task Order 12 executed on October 29, 2019, and the agreement between AECOM and NID dated April 15, 2015.

1.2 Scope of Work

The scope of work for this OPCC TM included the following tasks:

- Prepared conceptual figures for the Rollins Embankment Dam Raise. Similar figures have been prepared previously for RCC dam Concepts 1 and 2 (AECOM, 2018b and 2019). Stability, hydraulic, structural, and all other design-level analyses are beyond the scope of work for this TM.
- Prepared quantity estimates and OPCC's for the three concepts. The OPCC's were prepared so that the costs can be compared to those reported in the Centennial Reservoir Project, Roller Compacted Concrete Dam, Opinion of Probable Construction Cost – Final (AECOM 2017). The base year for the estimates is 2017; the estimates were escalated to 2019 dollars to compare the OPCC's of the concepts. The OPCC's were developed to a Class 4 level in accordance with the Association for the Advancement of Cost Engineering (AACE). For the RCC dam concepts, unit prices were based on those for Centennial Reservoir RCC dam (AECOM, 2017). Detailed "bottom-up" estimates are beyond the scope of work for the OPCC's described in this TM.

- Prepared this TM to compare the concepts on the basis of the OPCC's and quantities. Constructability issues are discussed, and approximate construction durations are presented for each concept.

1.3 Organization of Technical Memorandum

After this introductory section, this TM is organized into the following sections:

- Section 2 discusses the RCC dam Concepts 1 and 2 including foundation treatment, spillway, outlet works and diversion facilities, required construction materials, and conceptual site layout.
- Section 3 discusses the raised embankment dam concept including foundation treatment, spillway, outlet works and diversion facilities, required construction materials, and conceptual site layout.
- Section 4 describes the construction sequencing and durations for each concept.
- Section 5 presents the basis for and the results of the OPCC's for each concept.
- Section 6 presents the summary and conclusions.
- Section 7 lists the references used to prepare this TM.

1.4 Acknowledgements

The following key AECOM personnel contributed to this OPCC TM:

- Project Manager: Michael Forrest, P.E., G.E.
- Principal-in-Charge: Theodore Feldsher, P.E.
- Construction Cost Estimator: Roy Watts
- Civil Engineer: Steve Tough, P.E.
- Independent Technical Reviewer: Joseph Barnes, P.E.

1.5 Limitations

The estimates presented in this TM reflect a professional conceptual-level OPCC, based on conceptual-level design layouts developed using limited available information on the surface and subsurface site conditions. While adequate to compare concepts, costs presented herein should not be used for financial planning for project construction.

AECOM represents that its services were conducted in a manner consistent with the standard of care ordinarily applied as the state of practice in the profession, within the limits prescribed by our client. No other warranties, either expressed or implied, are included or intended in this TM.

Information provided is solely for the use of NID within the defined intent and scope of work stated in this TM.

Table 1. Rollins Dam and Reservoir Concepts Comparison Matrix

Item	Existing Rollins Embankment Dam (STID, NID, 2014)	Raised Rollins Embankment Dam (NID Water Supply Project Alternatives, Draft Environmental Support, AECOM, 2018a)	RCC Dam Concept 1 (Draft Tech Memo, AECOM, 2018b)	RCC Dam Concept 2 (Draft Tech Memo, AECOM, 2019)
Max. Structural Height (ft)	252.5	306	322	320
Dam Crest El. (ft)*	2,190.1	2,243.5	2,262.0 (est.)	2,262.0 (est.)
Crest Length (ft)	1,260	1,500 (approx.)	3,300	2,650
Crest Width (ft)	30	30	25	25
Upstream Slope	2.5H:1V	2.0 – 2.5H:1V	Vertical	Vertical
Downstream Slope	2.0H:1V	1.8H:1V	0.8H:1V	0.8H:1V
Estimated Dam Volume (cy)	2.4 million	2.1 million (increase)	2 million	1.3 million
Spillway Crest El. (ft)*	2,173.6	2,226 (52.4-foot raise)	2,242.4	2,242.4
Reservoir Area at Spillway Crest (acres)	826	1,301 (475-acre increase)	1,545 (719-acre increase)	1,500 (674-acre increase)
Reservoir Storage at Spillway Crest (acre-feet)	60,000	110,000 (50,000-acre-foot increase)	140,000 (80,000-acre-foot increase)	136,000 (76,000-acre-foot increase)
Spillway Description	Right abutment, 316 feet long, ungated ogee crest	Right abutment, 316 feet long, ungated ogee crest (raised)	New spillway over west side of dam, 250 feet long, ungated ogee crest	New spillway over west side of dam, 250 feet long, ungated ogee crest; utilizes existing spillway chute
Outlet Works	72- to 60-in. pipe to Howell-Bunger valve discharge into tunnel	May need to modify existing outlet works	Extend existing water supply and power conduits through RCC dam	Utilizes existing water supply and power conduits
Cofferdam	N/A	None	Existing dam acts as cofferdam	Construct cofferdam after reservoir is dewatered
Total Disturbance Area, permanent and temporary,	N/A	130	120	75

beyond reservoir area (acres)**				
Reservoir Level During Construction	N/A	~El. 2140 for excavation of existing dam crest - one season	El. 2040 to excavate notch through existing dam after RCC dam completed	Empty reservoir
Power Generation during Construction	N/A	No	Yes	No
Water Deliveries to Bear River Canal	N/A	Yes, may be limited due to reduced reservoir storage	Yes	Yes, may be limited due to reduced reservoir storage

*Vertical datum is NAVD 88
**Approximate area of restoration

2 Roller Compacted Concrete Dam

Conceptual-level designs were developed to illustrate the general arrangement and the main features for RCC dam Concepts 1 and 2. These concepts are described in draft TMs by AECOM referenced as 2018b (Concept 1) and 2019 (Concept 2) and are summarized below:

- RCC Dam Concept 1: A downstream dam location was considered to allow use of the existing Rollins Reservoir during construction. The existing dam would act as a cofferdam during construction of the downstream RCC dam. The location of RCC Dam Concept 1, downstream of the existing Rollins Dam, was selected based on the following considerations: (1) continue to provide water delivery to the Bear River Canal during construction of the downstream RCC dam; (2) continue to operate the existing hydropower plant during construction of the downstream RCC dam; and (3) continue to use the existing spillway to pass spill events safely through the downstream construction site.
- RCC Dam Concept 2: RCC Dam Concept 2 would require taking the reservoir out of service during construction, diverting flows around the dam site, and removing the existing embankment dam. The location of the RCC Dam Concept 2 was established to (1) keep the dam axis as far downstream as possible to minimize reservoir storage loss; (2) maximize utilization of the foundation excavation of the existing embankment dam; and (3) enable utilization of the existing spillway chute. The RCC dam footprint was located to include the existing dam core trench to reduce the foundation excavation volume. The dam axis bends perpendicularly to the existing spillway chute, so that the new RCC dam spillway would discharge down the existing spillway chute alignment.

The conceptual plans, sections, dam site areas and material balance diagrams for the RCC dam concepts are shown on Figures 2 to 6 (Concept 1) and on Figures 7 to 11 (Concept 2). The main features of the RCC dam and enlarged reservoir concepts are summarized in Table 1.

2.1 Dam Foundation Treatment

The dam layouts and assumed depths of foundation excavation are based on the results of the geotechnical reconnaissance (AECOM, 2018c) and on the as-built Rollins Dam Drawings (NID, 1966). As discussed in the 2018 and 2019 TMs, the foundation for an RCC dam would require slightly weathered to fresh, hard rock. Excavation depths up about 50 feet are expected in portions of both potential axis locations. Shallower excavation depths are anticipated in the river channel areas based on outcrop observations. Additional geotechnical investigations are needed to better define the necessary excavation depths.

Grouting would be needed to control seepage through the foundation rock. Based on a the as-built Rollins Dam drawings (NID, 1966), the grout curtain holes were drilled and grouted to a depth of 50 percent of the reservoir head, but not less than 25 feet deep. The grouting records show that the maximum grout hole depth was about 145 feet. The conceptual RCC dam design layouts include two grout curtains, each 150 feet deep in the central part of the dam foundation and 100 feet deep on the abutments as shown on Figures 3 and 8 (AECOM, 2018b and 2019). Grout hole spacing within a curtain was assumed to be 12 feet between primary and secondary holes, with tertiary and higher-order holes split-spaced between the primary and secondary holes. The grout holes in each curtain would be angled in opposing directions to more effectively intersect rock discontinuities in the foundation.

For conceptual design, the grout curtain will be located along a concrete plinth, anchored into the rock foundation, at the upstream toe of the dam as shown on Figures 4 and 9. The plinth will act as a grout cap and will be sealed against the upstream face of the RCC dam with waterstops. This grout curtain location would remove grouting from the critical path and can be undertaken as the dam is constructed.

The foundation for an RCC dam at either axis could also require consolidation grouting of fractured rock areas within the footprint. The purpose of this is to strengthen the rock mass and increase the stiffness of the foundation. The conceptual design layout includes consolidation grouting over 30% of the dam foundation footprint area, with 30-foot deep grout holes spaced on a 10 x 10-foot pattern.

Drain holes to control uplift pressures beneath the RCC dam would also be required. The conceptual design includes drain holes drilled from a gallery within the dam, spaced on 10-foot centers and extending to an average depth of 80 feet into the foundation rock.

The construction costs for an RCC dam would also include foundation cleaning for geologic mapping, final foundation cleaning prior to RCC placement, surface preparation (i.e., dental excavation of joints and shear zones and replacement with concrete), and leveling concrete placed on the foundation to provide a platform to commence RCC placement.

2.2 Conceptual Layout of Dam and Appurtenant Structures

The conceptual plans, profiles, and sections of the RCC dam are shown on Figures 2 to 4 for Concept 1 and on Figures 7 to 9 for Concept 2. The descriptions of the design for these RCC dam concepts are discussed in draft TM's (AECOM, 2018b, for Concept 1, and AECOM, 2019, for Concept 2). The conceptual section has a vertical upstream face, a 0.8H:1V stepped downstream face, and a 25-foot-wide crest. For the purpose of this OPCC, grout-enriched RCC (GE-RCC) facings on the upstream and downstream sides were assumed. The spillways were assumed to be faced with concrete.

2.2.1 Spillway Configurations

The conceptual RCC dam layouts for Concepts 1 and 2 include a spillway integral with the body of the dam, aligned to discharge flows directly into the Bear River channel. RCC Dam Concept 1 includes a spillway on the right side of the dam at the location of the existing spillway discharge, in a 250-foot wide overflow bay (Figure 2).

For Concept 2, the 250-foot wide spillway overflow bay is located immediately upstream of the existing spillway crest and would discharge down the existing chute alignment. The existing spillway chute was assumed to be demolished and replaced with a new reinforced concrete chute that meets current spillway design standards that would include underdrains, anchors to resist uplift forces and appropriate joint design. The lower end of the spillway chute would be widened from its present 80 feet to 150 feet to reduce the flow convergence from the 250-foot-wide crest at the top of the spillway. This is done to reduce the potential for cross waves during high flows under the increased spillway head of the raised dam. The existing spillway chute would need to be evaluated to confirm that it satisfies hydraulic design criteria. Also, a condition assessment of the existing spillway chute would be needed to confirm whether it would require modifications to bring it to current structural design standards (AECOM, 2019).

2.2.2 Outlets

For both RCC dam concepts, the two outlet works tunnels in the left abutment of Rollins Dam would be utilized for reservoir release (Figure 2 for Concept 1 and Figure 7 for Concept 2). The water supply outlet discharges to a forebay that feeds the Bear River Canal and the other outlet connects with the power plant at the downstream toe of the dam. The water supply outlet would be extended across the RCC Dam Concept 1 footprint to discharge into a relocated forebay that would feed the Bear River Canal. The headworks for the canal would also be relocated downstream of the construction area for Concept 1. The forebay would require a small canal forebay dam between the canal headworks and the RCC dam (Figure 2).

This OPCC TM also includes costs for a low-level outlet. The layout includes an assumed 8-foot diameter steel outlet pipe, which would be cast into the body of the RCC dam. The conceptual layout includes a single low-level intake, located near the base of the dam.

2.2.3 Diversion

For construction of RCC Dam Concept 1, the existing spillway would need to remain operable to safely convey spill events through the construction site. To accomplish this, a reinforced concrete box culvert structure would be constructed in the spillway discharge channel within the footprint of the RCC dam (Figures 2 and 3). This box structure would be required until the RCC dam is completed, and then filled with concrete and contact grouted to form a seal around the plug and the interior surface of the box structure.

To construct RCC Dam Concept 2 at the existing dam location, diversion would be needed through the existing tunnels in the left abutment. A cofferdam constructed within the emptied reservoir would be needed as was the case for the original dam construction in the 1960s (see Figure 7). The adequacy of the cofferdam height and tunnel capacity would need to be confirmed. Sediment scour within the emptied reservoir upstream of the cofferdam for this concept would need to be addressed.

2.3 Construction Materials

For RCC Concept 1, rock for RCC aggregate was assumed to be obtained from an on-site rock borrow area (see material balance diagram for RCC Dam Concept 1 on Figure 6). The rock borrow area would first need to be stripped of overburden and weathered rock. The underlying fresh rock would be drilled, blasted, crushed and screened to produce the RCC aggregate. Waste material would be placed in an on-site disposal area as discussed in Section 2.4.

For RCC Concept 2, the existing embankment dam shell materials would be stockpiled for use as RCC dam aggregate, and the clayey core materials would be wasted in disposal sites (see material balance diagram for RCC Dam Concept 2 on Figure 11). Once the existing dam has been removed, the foundation excavation for the RCC dam would proceed in the existing dam foundation.

The RCC, concrete, aggregate, cement and fly ash requirements are summarized in Table 2.

Table 2. RCC Dam Concepts 1 and 2 – Summary of Material Requirements

RCC Dam Concept	RCC Volume (cy)	Concrete Volume (cy)	Aggregate (process on-site) (cy)	Total Cement (import) (tons)	Total Fly Ash (import) (tons)
1	2,000,000	95,000	1,781,000	166,000	156,000
2	1,300,000	49,000	1,146,000	106,500	100,500

Note: See also Material Balance Diagrams, Figure 6 (Concept 1) and Figure 11 (Concept 2).
Cement and fly ash contents for RCC are each 150 lbs/cy.

The highest demand for cement and fly ash would be during RCC placement. The cement and fly ash would be imported and trucked to the RCC batch plant. Over the estimated 26-month and 17-month RCC placement periods for Concept 1 and Concept 2, respectively (see Sections 4.2 and 4.3), this would necessitate importing a total amount of about 560 tons per day of cement and fly ash. This hauling could potentially be limited to Monday through Friday during daylight hours if necessary. In that case, an estimated 14 truck loads per day would be required, at 40 tons per load.

The RCC would be mixed in an on-site batch plant, transported to the dam with a conveyor system, placed in 12-inch-thick lifts, and compacted with 10-ton smooth drum vibratory rollers. It was assumed that the RCC would be faced with grout enriched (GE) RCC and concrete (in the spillway) placed at the same time as the RCC.

RCC would not be placed during rainy weather. During hot weather, RCC placement may be limited to night-time placements or the aggregates may need to be cooled for mixing to stay below maximum allowable placement temperature requirements. This can be achieved by shading, water spraying, and/or by liquid nitrogen injection into the mix at the batch plant.

2.4 Conceptual Layout of Site Construction Plan

Conceptual site layouts for RCC dam construction are shown on Figure 5 for Concept 1 and Figure 10 for Concept 2. These figures show the assumed rock borrow area and disposal and staging areas. The estimated disposal volumes for the RCC dam concepts are approximately 4.6 million cy and 1.5 million cy for Concepts 1 and 2, respectively (refer to material balance diagrams, Figures 6 and 11 for Concepts 1 and 2, respectively). The disposal volume for Concept 1 is much greater than for Concept 2 mainly due to the borrow area stripping volume and greater foundation excavation.

The main construction site features would include the rock borrow area (for Concept 1), aggregate crushing and screening plant, disposal area, RCC batch plant, concrete batch plant, and staging areas. The staging area would contain the contractor and construction management offices, site geotechnical and RCC/concrete laboratory, fuel depot, and equipment laydown and storage areas. The conceptual locations of the site features were developed based on access and proximity to the dam sites.

Access routes for construction would be the responsibility of the construction contractor. Two-lane all-weather road access would be needed to connect the rock borrow area (for RCC Dam Concept 1) with the aggregate crushing and screening plant areas, the RCC batch plant site on the left abutment of the dam, and the concrete batch plant.

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3 Rollins Embankment Dam Raise

The conceptual design for the raised embankment dam to store an additional 50,000 acre-feet was prepared in February 2018 to provide information for environmental support (AECOM, 2018a). Figures prepared for this OPCC TM showing the conceptual plan, section, dam site area and material balance diagram are included as Figures 12 to 16. The main features of the raised embankment dam and enlarged reservoir concept are summarized in Table 1.

3.1 Dam Foundation Treatment

The raised dam would extend beyond the end of the left end of the existing dam. In this area, the excavation would extend about 30 to 50 feet below the ground surface. The core zone would extend down to moderately weathered or better rock conditions. The raised downstream dam shell zone would be founded on weathered rock. The right abutment would include a concrete gravity wall (see Section 3.2) founded on moderately weathered or better rock conditions.

Grouting would be needed to control seepage through the abutment rock that would tie into the existing grout curtain. For estimating purposes, the average depth was assumed to be 50 feet on the left abutment and 100 feet on the right abutment, with two curtains composed of holes angled in opposing directions to more effectively intersect rock discontinuities in the foundation. Grout hole spacing within a curtain was assumed to be 12 feet between primary and secondary holes, with tertiary and higher-order holes split-spaced between the primary and secondary holes.

3.2 Conceptual Layout of Dam and Appurtenant Structures

The conceptual plan, profile and section of the raised dam concept are shown on Figures 12 to 14. The top of the existing embankment would be excavated to allow for the dam raise (Figure 14). The 53.4-foot dam crest raise would include an inclined core zone that would be flanked by inclined filters and by rockfill shell zones. The raised embankment dam conceptual section has a 2H:1V upstream slope, a 1.8H:1V downstream slope, and a 30-foot-wide crest. Riprap would be placed on the upstream shell zone for wave erosion protection.

The existing spillway would need to remain functional throughout construction of the raised dam. The raise would begin by excavating the top of the dam to establish the inclined core zone and rebuilding the dam back to original crest elevation 2190.1 feet during the dry season to allow use of the spillway during the winter season (Section 4.4).

As stated in Section 3.1, the right abutment of the dam would include a concrete gravity wall to retain the raised embankment at the spillway location that would also form the left side of the spillway (Figure 13). The wall would be about 86 feet high and have a vertical face adjacent to the spillway and a backslope of 0.8H:1V against which the raised embankment would be placed.

The existing spillway chute was assumed to be demolished and replaced with a new reinforced concrete chute that meets current spillway design standards and would include underdrains, anchors and appropriate joint design. The spillway chute would be widened from its present 80 feet to 150 feet at the lower end of the spillway to reduce flow convergence from the 316-foot-wide crest at the top end of the spillway (NID, 1966). This is done to reduce the potential for cross waves during high flows under the increased spillway head of the raised dam. Similar to RCC Dam Concept 2, further analyses would be needed to define hydraulic conditions, rating curve, and the configuration of the spillway chute and its structural condition.

The two existing outlet conduits would be extended through the downstream raised embankment; one for the relocated powerhouse and one for the river outlet. The capacity of the outlet conduits would need to be evaluated to confirm that California Division of Safety of Dams (DSOD) reservoir drawdown criteria can be met.

3.3 Earth and Rock Construction Materials

Rockfill would be quarried from an on-site rock borrow area (Figure 15) and would provide the materials indicated in Table 3. Rockfill shell zones would be placed in 2- to 3-foot-thick loose lifts and compacted by heavy (12-ton) vibratory rollers. Lesser quality (weathered) rock can also be utilized in the downstream shell zone, but above the foundation surface, to allow for drainage through the underlying better quality rockfill. Filter zones could be imported from commercial quarries, or processed from on-site rock. The core materials would be obtained from the rock borrow area stripping as indicated on the material balance diagram shown on Figure 16.

Table 3. Materials for Embankment Dam Raise

Description	Material	Lift Thickness (in.)
Core	Colluvial clayey soils from borrow area stripping	8
Filters	Crushed and screened to sand and gravel sizes – imported or processed from on-site rock	12
Rockfill	Quarried pit-run rockfill	24-36
Riprap	Quarried and sorted rockfill	36 (layer on upstream slope)

*Refer to Figure 14 for zoning.

In order to produce the necessary quality of rockfill materials, the rock borrow area would need to be stripped of overburden and highly weathered rock. The wasted material would be placed in an on-site disposal area (Section 3.4). The underlying moderately weathered to fresh rock would be drilled and blasted to produce rockfill.

The summary of embankment dam raise material requirements is summarized in Table 4.

Table 4. Estimated Embankment Dam Raise Quantities

Description	In-place Material Volume cy)
Interim Raise:	
Exist dam crest excavation	333,000
Final Dam:	
Total volume of raise	1,646,000
Core zone	125,000
Filter and drain chimney zones (imported)	121,000
Rockfill and riprap	1,400,000
Concrete aggregate	54,000

Cement and fly ash would need to be imported for the concrete structures that total approximately 64,000 cy. It is estimated that approximately 10,000 tons of cement and 3,500 tons of fly ash would be required for the spillway chute, raised ogee crest and gravity wall. Hauling traffic for cement and fly ash would be heaviest during periods when these features are being constructed. It is estimated that up to about six 40-ton-loads per week would be needed to meet the demand to construct these features.

3.4 Conceptual Layout of Site Construction Plan

A conceptual site layout for the Rollins embankment dam raise construction is shown on Figure 15. This figure shows the assumed rock borrow area, disposal areas and staging areas. The estimated disposal volumes for the embankment dam raise concept is approximately 1.4 million cy (refer to the material balance diagram, Figure 16).

The main construction site features would include the rock borrow area, disposal area, concrete batch plant, and staging areas. The staging area would contain the contractor and construction management offices, site geotechnical and concrete laboratory, fuel depot, and equipment laydown and storage areas. The conceptual locations of the site features were developed based on access and proximity to the dam site.

Access routes for construction would be the responsibility of the construction contractor. Two-lane all-weather road access would be needed to connect the rock borrow area with the dam site and aggregate crushing and screening plant areas, and the concrete batch plant site.

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4 Construction Sequencing and Durations

4.1 General

The construction sequencing and durations discussed in this section provide a means to comparatively assess the relative logistics and construction durations of the activities of the Rollins dam concepts. The estimated construction durations focus on the major activities most likely to influence the total construction durations.

Many variables were considered in estimating the construction durations including productivities (which depend on crew sizes, equipment spreads, access conditions, etc.), approaches to sequencing of activities, number of shifts per day and days per work week, and other factors. The resulting construction duration estimates are approximate, and are consistent with the conceptual level of the corresponding OPCC's for each concept. The estimated construction durations discussed below may be conservative; optimization is possible once the project and geotechnical conditions are better defined in future phases of investigation and design.

The construction sequencing discussed in this section is our conceptual assessment of how the work could be executed. For this conceptual level estimate, durations of construction were estimated for the major work activities based on the work quantities and typical productivity rates. Productivity rates were estimated based on experience on other projects of similar type and magnitude. The following points summarize general assumptions and average productivity rates used to develop the estimated construction activity durations:

- Work performed six days per week, up to two shifts per day
- Placement of RCC and earthfill would occur between April 1 and November 15.
- No overly restrictive constraints on trucking materials to the site
- Dam foundation excavation: 30,000 cy/week
- Existing dam excavation: 30,000 cy/week
- Foundation grouting: 600 lineal feet per week per drill rig/grout plant
- RCC construction: 18,000 cy per week (based on information in AECOM, 2018d)
- Embankment dam raise construction: 50,000 cy per week below existing dam crest and 25,000 cy per week above existing dam crest

4.2 RCC Dam Concept 1

The main construction activities for RCC Dam Concept 1 for each year of construction are summarized below.

<u>Year 1:</u>
- Mobilize equipment and personnel to site
- Site development includes establishing BMPs and environmental protection features, access roads, and staging, stockpile, and disposal areas

- Develop borrow area
- Begin foundation excavation
- Construct temporary spillway bypass

Year 2:
- Complete foundation excavation
- Begin RCC placement and foundation surface preparation
- Begin foundation grouting
- Start construction of new intake structure and outlet

Year 3:
- Continue RCC placement and foundation surface preparation
- Continue foundation grouting
- Complete construction of new intake structure and outlet

Year 4:
- Complete RCC placement and foundation surface preparation
- Complete foundation grouting
- Drill drain holes from gallery
- Start construction of spillway training walls on RCC dam
- Lower reservoir and excavate notch through existing dam

Year 5:
- Complete construction of spillway training walls on RCC dam, dam crest slab and parapet walls
- Construct bridge
- Plug temporary spillway bypass
- Construct misc. civil works
- Install electrical, instrumentation and SCADA
- Site restoration and demobilize from site

It is estimated that the RCC Concept 1 could be constructed in about 4½ to 5 years (excluding any environmental mitigations).

4.3 RCC Dam Concept 2

The main construction activities for RCC Dam Concept 2 for each year of construction are summarized below.

Year 1:
- Mobilize equipment and personnel to site
- Site development includes establishing BMPs and environmental protection features, access roads, and staging, stockpile, and disposal roads
- Construct cofferdam for diversion
- Remove powerhouse and equipment.
- Begin excavation of existing dam and stockpile for RCC aggregate.

Year 2:
- Complete excavation of existing dam and stockpile for RCC aggregate.
- Excavate dam foundation

Year 3:
- Begin RCC placement and foundation surface preparation
- Begin foundation grouting
- Start construction of spillway walls

Year 4:
- Complete RCC placement and foundation surface preparation
- Complete foundation grouting
- Drill drain holes from gallery
- Construct spillway training walls on RCC dam and dam crest slab and parapet walls
- Complete construction of new intake structure and outlet
- Demolish existing chute spillway and excavate for new spillway
- Start construction of new spillway chute

Year 5:
- Complete new spillway chute
- Construct bridge
- Construct misc. civil works
- Install electrical, instrumentation and SCADA
- Site restoration and demobilize from site

Similar to RCC Dam Concept 1, it is estimated that the RCC Concept 2 could be constructed in about 4½ to 5 years (excluding any environmental mitigations).

4.4 Embankment Dam Raise Concept

The main construction activities for the embankment dam raise concept for each year of construction are summarized below.

Year 1:

- Mobilize equipment and personnel to site
- Site development includes establishing BMPs and environmental protection features, access roads, and staging, stockpile, and disposal roads
- Develop borrow areas
- Construct lower portion of right abutment gravity wall

Year 2:

- Lower reservoir level to interim elevation 2142.6 feet by May 1 for interim dam crest construction
- Start importing and stockpiling filter and drain materials for dam raise
- Excavate foundation and abutments
- Begin grouting of abutments
- Excavate dam crest to interim level (above reduced reservoir level) and haul to stockpile
- Rebuild dam back to original crest elevation 2190.1 feet to allow spillway use during winter season and construct rockfill shell on downstream side of dam
- Construct remaining portion of right abutment gravity wall

Year 3:

- Complete grouting of abutments
- Complete importing and stockpiling filter and drain materials for dam raise
- Complete embankment construction to final crest elevation
- Demolish existing chute spillway and excavate for new spillway

Year 4:

- Construct new spillway chute
- Construct bridge
- Construct misc. civil works
- Install electrical, instrumentation and SCADA
- Site restoration and demobilize from site

It is estimated that the Rollins dam raise could be constructed in about 4 years (excluding any environmental mitigations).

5 Construction Cost Estimates

5.1 General

This section describes the cost estimating methodology and basis for development of comparative conceptual-level OPCC's for both RCC dam concepts and the embankment dam raise concept.

5.2 Project Features

The OPCC's were developed by dividing the project into the following major features or cost categories for each dam type:

A. Mobilization and demobilization

B. Site development

C. River diversion

D. Dam foundation

E. RCC, facing concrete and gallery for the two RCC dam concepts, or embankment construction for the Embankment Dam Raise Concept

F. Spillway and dam crest

G. Spillway bridge

H. Outlet and intake structures and pipe

I. Misc. civil

J. Instrumentation and SCADA

The following sections describe the major cost components and estimating assumptions applicable to each of the above features and construction activities.

5.2.1 Mobilization and Site Development

Mobilization expenses include contract administration, temporary facilities (e.g., site offices and materials laboratory), transporting equipment to the site, and contract execution costs. Expenses associated with contract administration include preparation of submittals, coordination and meetings, insurance, taxes, and bonds. Expenses associated with temporary facilities include costs to furnish and set up temporary facilities, utilities, and roads at the site preparatory to undertaking construction work. Also included are costs for transporting construction equipment to site, unloading and assembly of the equipment, and break down and load out at the end of construction. Expenses associated with contract execution include layout and survey and contract closeout.

Site development includes construction and improvement of existing access roads, layout and construction of new haul roads, environmental protection, erosion and sediment control, stripping of surface soils prior to excavation, and borrow area development.

5.2.2 River Diversion

As stated in Section 2.2.3, for construction of RCC Dam Concept 1, the existing spillway would remain operable to convey spill events through the construction site. A reinforced concrete box culvert structure would be constructed in the spillway discharge channel within the footprint of the RCC dam. The existing tunnels would also be used for diversion. For RCC Dam Concept 2, a cofferdam would be constructed within the emptied reservoir so that flows could be diverted through the existing tunnels in the left abutment. The existing spillway would be used to discharge flows during construction of the raised embankment dam concept (Section 3.2). The existing tunnels would also be used for diversion.

5.2.3 Dam Foundation Excavation and Preparation

The dam foundation work would include excavating, loading, and hauling the materials that are removed from the foundation and abutments to the disposal area shown on Figure 5 (RCC Dam Concept 1), Figure 10 (RCC Dam Concept 2), and Figure 15 (Embankment Dam Raise Concept). This would be followed by foundation clean-up; preparation; leveling concrete for the RCC dam foundation; dewatering and groundwater control; and setting up, mixing and injecting grout for the grout curtain. Construction pricing assumptions for the dam foundation excavation and preparation work include the following:

- Foundation excavation was broken out as “common excavation” assuming large haul trucks and loader/excavator equipment spreads, but no drilling and blasting, and “rock excavation” requiring systematic drilling and blasting. The developed unit prices per cubic yard were compared with historical and database unit prices for consistency.
- Cleaning and preparation of the foundation surfaces were estimated per square yard using historical and database unit prices.
- Grout hole depths and primary and secondary hole spacing are indicated in Section 2.1 for the RCC dam concepts and in Section 3.1 for the embankment dam raise concept. An allowance of 50% for tertiary and higher-order holes are included in the OPCC’s. Costs for the grout curtain construction were estimated based on the lineal feet of grout holes drilled; verification holes, water pressure tests and the estimated weight of cement injected into the drill holes (0.35 sacks of cement/lf) are included in the drill hole footage price. An allowance for consolidation grouting is also included in the OPCC’s for the RCC dam concepts at 30% of the foundation area.

5.2.4 RCC Dam and Concrete Facing

The estimated cost for RCC construction assumes that the concrete aggregate would be processed from rock obtained from the on-site rock borrow area (for RCC Dam Concept 1) and from the existing dam shell zones (for RCC Dam Concept 2). The aggregate cost includes drill and blast excavation at the rock borrow area, crushing and screening, transporting and placing in stockpiles, loading from stockpiles, and hauling to the RCC batch plant at the top of the left abutment of the dam. The RCC cost also includes mixing the aggregate, cement and fly ash, transporting the RCC mix to the dam by conveyor, spreading and leveling the RCC to 12-inch thick lifts, and compacting with heavy smooth drum vibratory rollers. The estimate assumes the concrete facing/GE-RCC zones would be formed and placed simultaneously with the RCC placement and compaction.

5.2.5 Embankment Dam Raise

The rockfill embankment construction cost includes materials, labor, and equipment components. The estimated costs for rockfill materials include drill and blast excavation, loading, hauling, placing, and compaction of rockfill material obtained from the on-site rock borrow area for the embankment raise concept. Estimated costs for the imported filter/drain zones include purchasing from a commercial quarry, transporting and stockpiling the materials, loading from the stockpiles, hauling, placing, and compacting in the dam. The assumed placement lift thicknesses for each material zone are indicated in Table 3. Compaction of rockfill and filter/drain zones would be performed with heavy smooth drum vibratory rollers.

The core materials would be stripped from the surface of the rock borrow area and stockpiled until they are ready for placement in the dam, when the embankment fill reaches the base of the core (elevation 2142.6 feet on Figure 14). Moisture conditioning of these materials would take place in the stockpile area.

5.2.6 Spillway and Bridge

The chute spillway construction costs include demolition of the existing spillway concrete; rock excavation to widen the lower end of the spillway chute (with both drill and blast and mechanical methods); installation of anchors and subdrainage facilities; and structural concrete placement for the base slab and sidewalls. Historical database unit prices were used to estimate the cost of the spillway structural concrete walls and slab. Demolished concrete was assumed to be disposed in the on-site disposal area (Figures 10 and 15), but encapsulated within the earth and rock materials placed in the disposal area. Alternatively, the demolished concrete could be disposed off site in a landfill or recycling facility; this would result in additional hauling costs and facility/landfill disposal fees. The spillway bridge includes pre-fabricated segmental box-girder construction and piers.

5.2.7 Outlet and Intake Structures

The outlet works components for the RCC dam concepts include an intake at the base of the dam and a steel outlet pipe through the dam. In addition, major components were assumed to include the intake trashrack, control gates and valves, and associated electrical and mechanical systems. Detailed conceptual design layouts were not developed for the outlet works structure, so costs were estimated from experience on other similar projects. For the embankment dam raise concept, the two existing outlet conduits (power and river outlet) would be extended through the raised embankment.

5.2.8 Miscellaneous Civil Works

The cost category includes backfill, channel riprap, light duty paved maintenance roads, and site restoration (erosion control, grading and seeding).

5.2.9 Instrumentation and SCADA

The dam concepts would include instrumentation to monitor dam performance such as piezometers, survey monuments to monitor settlement and movement, inclinometers, and accelerographs. An automated data acquisition system (ADAS) is also assumed, to transmit the data to a central receiving location. Both dam concepts are also assumed to include supervisory control and data acquisition (SCADA) systems to operate the outlet works gates and valves. ADAS and SCADA data transmission would be via telemetry or land line. The estimates include cost allowances for these systems based on experience on other similar projects.

5.3 Quantity Estimates

The major project features were identified and broken down into separate work items for which quantities were then estimated for construction costing. The quantity estimates are dependent on the level of conceptual design detail as discussed in Sections 2 and 3. At the conceptual design level, the focus is on major features and related items of work. For development of the OPCC's, the earthwork quantities (foundation excavation, rockfill embankment and RCC) were calculated from the estimated conceptual design cross sections using average end area methods for sections cut on up to 200-foot spacings. The quantities represent in-place volumes, either in-situ or in-dam, as appropriate. Quantities for the spillways were estimated based on the layouts shown on the conceptual design figures presented in Sections 2 and 3.

5.4 Material Balance Diagrams

The material balance diagrams on Figures 6, 11 and 16 for RCC Dam Concept 1, RCC Dam Concept 2, and Embankment Dam Raise Concept, respectively, show the flow of materials from source to destination. They indicate the estimated amount of required rock borrow material, RCC dam and embankment quantities, excavated waste materials to be disposed, and the amount of imported cement and fly ash. Estimates for material bulking and shrink factors are also indicated on the figures. Materials to be run through aggregate processing and RCC and concrete batch plants are also indicated.

5.5 Pricing

5.5.1 Class of Cost Estimate

The conceptual-level OPCC's presented in this TM are intended to represent bid prices received from qualified contractors. The OPCC's are generally consistent with Class 4 estimates, which are described by the Association for the Advancement of Cost Engineering (AACE, 2005) as follows:

> "Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 15% complete."
>
> "Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side."

Accordingly, the conceptual level Class 4 OPCC's presented in this TM are expected to fall within a range from 20% below to 20% above the actual construction cost for a given concept.

5.5.2 Basis of OPCC's

An experienced cost estimator with construction and hard dollar contract bid experience prepared the OPCC's, using logic, methods, and procedures that are typical for the heavy civil construction industry. Costs were estimated based on historical and database unit prices, and on built-up unit prices for Centennial Dam (AECOM, 2017). Other elements not detailed in the conceptual designs were priced as lump sum allowances in the estimated construction cost based on experience on similar projects. Construction costs from similar projects were considered in developing the estimate, including projects under construction and already completed.

For comparative OPCC's in this TM, the unit prices developed in mid-2017 (Quarter 2) for the Centennial Reservoir Project (AECOM, 2017) were used for the corresponding items for RCC dam Concepts 1 and 2, and for similar items for the Rollins Dam enlargement. The total construction costs were escalated to the end of 2019 (Quarter 4) using published indices from the U.S. Bureau of Reclamation's (USBR) Construction Cost Trends. Using the indices, the escalation from mid-2017 to the end of 2019 is about 8%.

Construction costs for the features and items were estimated by developing unit costs and multiplying these by the estimated quantities. Unit prices in the OPCC's were based on recently completed similar work and checked using the labor and equipment rates from the U.S. Army Corps of Engineers (USACE) Region VII Construction Equipment Ownership and Operation Expense Schedule (USACE, 2014). Vendor quotes were used for materials obtained off-site. Concrete costs were based on the use of an on-site concrete batch plant.

Cost breakdowns are presented in Appendix A. Direct and indirect costs were estimated for each of the main work items of the project. The direct costs include the quantity of work, labor, equipment, material and other costs estimated for each item. The general requirements of the contract (supervision and office staff, offices, utilities, etc.) are estimated to be about 20% of the direct construction cost. The contractor's markup at 15% of the direct construction cost includes general and administrative costs (G&A) and profit. G&A covers home office overhead cost and typically is in the range of 3 to 5% of the direct construction cost. G&A costs were assumed to comprise 5% of the estimated direct construction cost and profit was assumed to be 10% of the estimated direct construction cost. Prevailing wage (Davis-Bacon) rates were used to estimate labor costs. The direct and indirect costs (general requirements and markup) were added together to arrive at total unit costs.

All pricing assumes that the contractor is qualified and experienced in the construction of large RCC and embankment dams. The OPCC's also assume that the contractor would calculate and offer construction pricing from an open and competitive design-bid-build approach under one general construction contract utilizing industry standard specifications.

5.6 Design Contingency

The OPCC's presented in this TM include items, quantities, requirements, and constraints that have not been fully identified, or else are not fully investigated or designed. In later stages of design, the scope of the project also tends to expand as more detail is developed and as regulatory agencies undertake more detailed reviews. To account for the items that have not yet been fully developed, a design contingency allowance has been included in each OPCC.

The amount of design contingency reflects the degree of risk associated with uncertainties, particularly with respect to geotechnical conditions, as well as the completeness of the design detail for the major categories. The design contingency is based on, and added to, the subtotal of construction costs because it represents an unknown portion of the total estimated construction cost. The recommended design contingency normally decreases as the project design advances, more information becomes available, project requirements become better defined, and more design detail is captured in the subtotal of construction costs.

The OPCC's presented in this TM each include a design contingency, incorporated as an integral part of the estimated construction cost to accommodate those features and items of the work that cannot yet be fully assessed due to the conceptual level of the current design. In the OPCC's presented in Appendix A, the estimated percent contingencies are distributed to the various line items to reflect uncertainty in each item. The weighted average contingencies for the three concepts are as follows:

- RCC Dam Concept 1: 27.2%
- RCC Dam Concept 2: 26.4%
- Rollins Embankment Dam Raise: 29.8%

These contingencies are considered to be in the appropriate range (25% to 30%) for AACE Class 4 cost estimates.

5.7 Allowances and Exclusions

In order to assist NID to evaluate some of the other owner-related project costs, the allowances included below for design engineering, construction management, and engineering services during construction are provided. These are approximated as percentages of the total construction cost, based on recent experience with similar large infrastructure projects in California. Typical ranges for these costs depend in large part on the specific project details and total costs:

- Design engineering (includes geotechnical investigations): 5 to 8%
- Construction management and engineering services during construction: 8 to 10%

There are other potential owner-related project costs, but they are excluded from the OPCC's presented in this TM. These include NID's project management and administration costs, reservoir clearing[1], relocation of utilities, rebuilding of the power plant, land acquisition, legal, DSOD and FERC permitting fees, environmental permitting, environmental review and documentation, and mitigation. Other excluded items are cost to manage/regulate water for operations when reservoir is out of service during construction and loss of power generation for concepts when the hydropower plant is out of service.

In addition, potential construction cost growth due to change orders is not included in the OPCC's. Typical budgetary allowances for such costs can amount to 10% to 15% of the total construction cost, particularly for projects that involve relatively large amounts of geotechnical uncertainty.

[1] Reservoir clearing is assumed to occur under a separate timber harvesting contract.

5.8 Opinion of Probable Construction Cost

The conceptual design level OPCC's for the RCC dam and embankment raise concepts are summarized in Table 5. The OPCC details are presented in Appendix A. For comparison, the OPCC for Centennial dam is included in Appendix B. Breakdowns are presented for each of the categories and features described in Section 5.2. The recommended design contingency is distributed to each line item of the OPCC's as discussed in Section 5.6.

Although the project construction would occur a number of years in the future, the OPCC's presented in this TM were prepared in 2019 dollars and escalation to mid-point of construction is not considered. Potential issues that could impact future construction costs include changes in the construction industry bidding climate at the time the work is actually bid, increases in prevailing wage rates, and unpredictable fluctuations in material, equipment, and/or fuel prices.

Based on the approximate percentages indicated in Section 5.7, the total costs for design engineering and for construction management and engineering services during construction for the dam concepts are roughly estimated in Table 6.

Table 5. Opinion of Probable Construction Cost Summary

Rollins Reservoir Raise Concepts

Category	Description	RCC Dam Concept 1		RCC Dam Concept 2		Embankment Dam Raise Concept	
		Category Total	Category % of Total	Category Total	Category % of Total	Category Total	Category % of Total
A	Mobilization & Demobilization	$42,681,000	7.1	$30,367,000	7.2	$13,905,000	7.0
B	Site Development	$44,441,000	7.4	$21,389,000	5.1	$27,843,000	14.0
C	River Diversion	$1,950,000	0.3	$2,150,000	0.5	$2,600,000	1.3
D	Dam Foundation	$90,212,000	15.1	$88,884,000	21.1	$11,846,000	6.0
E	RCC & Facing Concrete	$349,440,000	58.5	$227,136,000	53.8	NA	NA
E	Embankment Dam Raise	NA	NA	NA	NA	$38,335,000	19.3
F	Spillway	$17,102,000	2.9	$32,585,000	7.7	$87,539,000	44.1
G	Spillway Bridge	$2,779,000	0.5	$2,779,000	0.7	$3,510,000	1.8
H	Outlet & Intake Structures & Pipe	$29,636,000	5.0	$10,482,000	2.5	$,8,332,000	4.2
I	Misc. Civil	$16,536,000	2.8	$4,434,000	1.1	$2,649,000	1.3
J	Instrumentation & SCADA	$2,210,000	0.4	$1,950,000	0.5	$1,950,000	1.0
	Total OPCC (Q2 2017)	$597,000,000	100.0	$422,200,000	100.0	$195,200,000	100.0
	Total OPCC (Q4 2019)	$644,800,000		$456,000,000		$210,800,000	
	Estimated Range – Low (-20%)	$515,800,000		$364,800,000		$168,700,000	
	Estimated Range – High (+20%)	$773,700,000		$547,200,000		$253,000,000	

Table 6. Other Owner-related Cost Allowances[1]

Concept	Design Engineering (includes geotechnical investigations)	Construction Management and Engineering Services during Construction
RCC Dam Concept 1	$32 - $52 million	$52 - $65 million
RCC Dam Concept 2	$23 - $36 million	$36 - $46 million
Embankment Dam Raise	$11 - $17 million	$17 - $21 million

[1] Not included in OPCC's.

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6 Summary and Conclusions

This TM presents opinions of probable construction costs (OPCC's) for the following enlarged Rollins Reservoir concepts:

- Raise Rollins Embankment Dam to store an additional 50,000 acre-feet.
- Roller Compacted Concrete (RCC) Dam, downstream location – RCC Concept 1, to store an additional 80,000 acre-feet. This concept would make use of the existing dam as a cofferdam during RCC dam construction.
- RCC Dam, existing dam location – RCC Concept 2 to store an additional 76,000 acre-feet. This concept would involve emptying the reservoir and diverting flows around the RCC dam construction site and removing the existing embankment dam, the shell zones of which could be processed to provide RCC aggregate.

This TM includes the conceptual plans and sections developed for the two RCC dam concepts and for the embankment raise concept, with conceptual construction site layouts for each of these concepts. The construction site layouts show the assumed rock borrow areas, disposal areas for surplus materials, and staging and laydown areas. The OPCC's assume that the on-site rock borrow area contains a sufficient amount of suitable material to produce the needed quantities of rockfill for the embankment dam raise or aggregate for RCC Dam Concept 1, or that the existing dam can be used to produce aggregate for RCC Dam Concept 2.

As part of preparing the OPCC's, conceptual level construction sequencing and durations were estimated for each dam type, to provide a comparative assessment of the relative construction durations of the RCC and embankment dam raise concepts. These assessments focus on the major construction activities and provide estimates of the total construction durations based on the current level of project development. These assessments indicate that the RCC dams could potentially be constructed in about 4½ to 5 years, and the embankment dam raise could take about 4 years to construct. These construction durations may be conservative.

The conceptual-level OPCC's presented in this TM are consistent with Class 4 estimates as described by the Association for the Advancement of Cost Engineering (AACE, 2005). The estimated accuracy range of the OPCC's is from 20% below to 20% above the actual construction cost for a given concept.

The OPCC's include design contingencies in the range of about 27% to 30%, to accommodate those features and items of the work that have not been defined at the current conceptual level of design development. This level of contingency is consistent with the typical range for an AACE Class 4 cost estimate.

Allowances are suggested for non-construction project costs including design engineering and for construction management and engineering services during construction. Other expected project costs, which are excluded from the OPCC's, but should be considered by NID include NID project administration and management, reservoir clearing, relocation of utilities, rebuilding of the power plant, land acquisition, legal, permitting, environmental review studies, and mitigation. Potential cost growth during construction due to unexpected changes and unforeseen conditions is also excluded from the OPCC's but should be considered in NID's future budget planning.

The relative OPCC's for the RCC dam and embankment dam raise concepts, in 2019 dollars, are summarized below in Table 7. As expected, RCC Dam Concept 2 would have a much lower cost than RCC Concept 1 due to its much lower RCC volume.

Table 7. Summary of Comparative Construction Costs

Concept	Reservoir Storage (acre-feet)	OPCC Range (2019)	Construction Cost Range per Acre-foot of Total Reservoir Storage
RCC Dam Concept 1	80,000	$645 million ($516 - $774 million)	$8,060 ($6,448 - $9,671)
RCC Dam Concept 2	76,000	$456 million ($365 - $547 million)	$6,000 ($4,800 - $7,200)
Embankment Dam Raise	50,000	$211 million ($169 - $253 million)	$4,216 ($3,374 - $5,060)

Development of more detailed designs is not warranted at this stage and so was not included in the scope of work. Significant geotechnical investigation and engineering and design analyses would be needed in future phases of work to further develop and refine the design layouts, dimensions, and sizes of the various project facilities.

In addition to further development of the dam and foundation designs, other important design elements would need to be considered and further developed as the project is advanced. These design elements, which each significantly affect the overall project cost and schedule, include the following:

- Foundation excavation requirements and resulting dam volume.
- Suitability of the existing dam shell zones for use in RCC aggregate.
- Required diversion requirements during construction (diversion design flood inflow and routed outflow) and outlet capacity requirements for emergency reservoir drawdown.
- Hydraulic analyses (including computational fluid dynamics modeling) and a condition assessment of the existing spillway to determine whether it would need to be upgraded to meet current standards (for RCC dam Concept 2 and the embankment dam raise).
- For the embankment dam raise concept, confirmation of stability of the inclined raised core concept and acceptance by the regulatory agencies.

7 References

AECOM, 2017. Centennial Reservoir Project, Roller Compacted Concrete Dam Opinion of Probable Construction Cost – Final. August 25.

AECOM, 2018a. NID Water Supply Project, Alternatives - Data Needs (submitted in response to request for information on potential Rollins and Jackson Meadows Reservoir enlargements). February 26.

AECOM, 2018b. Water Storage Project, Enlarged Rollins Reservoir Alternative [Concept 1], Technical Memorandum – Draft. December 13.

AECOM, 2018c. Rollins and Jackson Meadows Dams, Geologic Reconnaissance Mapping and Seismic Surveys, Technical Memorandum. January 25.

AECOM, 2018d. Letter to NID, Water Supply/Centennial Reservoir Project, RCC Dam Abstracts. March 19.

AECOM, 2019. Water Storage Project, Enlarged Rollins Reservoir Alternative, Concept 2, Technical Memorandum – Draft. May 20.

American Associated of Civil Engineers International (AACE), 2005. AACE International Recommended Practice No. 18R-97, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries. TCM Framework: 7.3 – Cost Estimating and Budgeting. February 2.

NID, 1966. Yuba-Bear Development, Rollins Dam, 1966. As-built Drawings. May.

NID, 2014. Supporting Technical Information Document (STID), Yuba-Bear Project, Rollins Dam, FERC No. 2266, 92 pp.

U.S. Army Corps of Engineers (USACE), 2014. Construction Equipment Ownership and Operation Expense Schedule, Region VII, EP-1110-1-8, Volume 7. April.

U.S. Bureau of Reclamation (USBR), Technical Service Center, Construction Cost Trends, usbr.gov/tsc/techreferences/mands/cct.html.

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Figures

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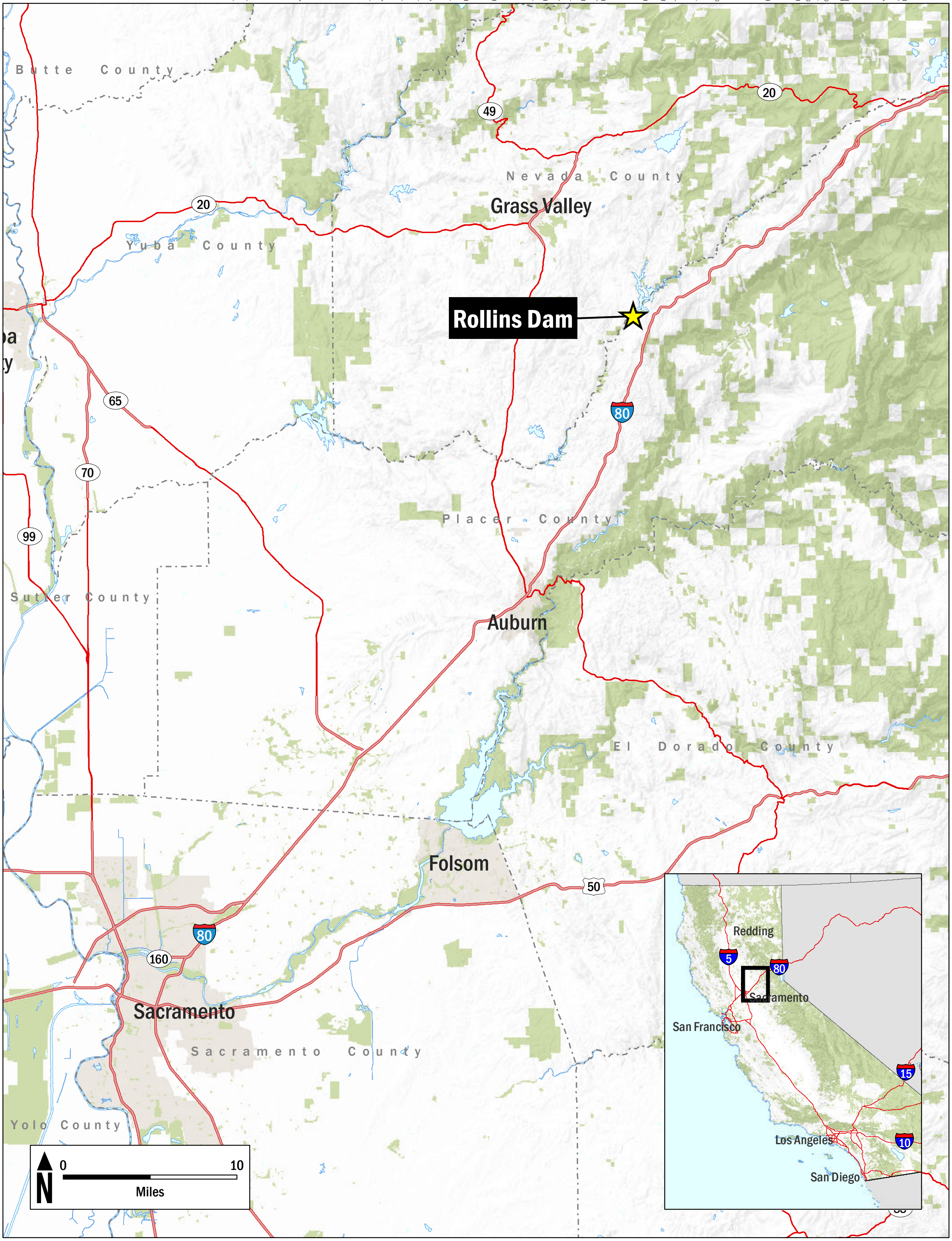
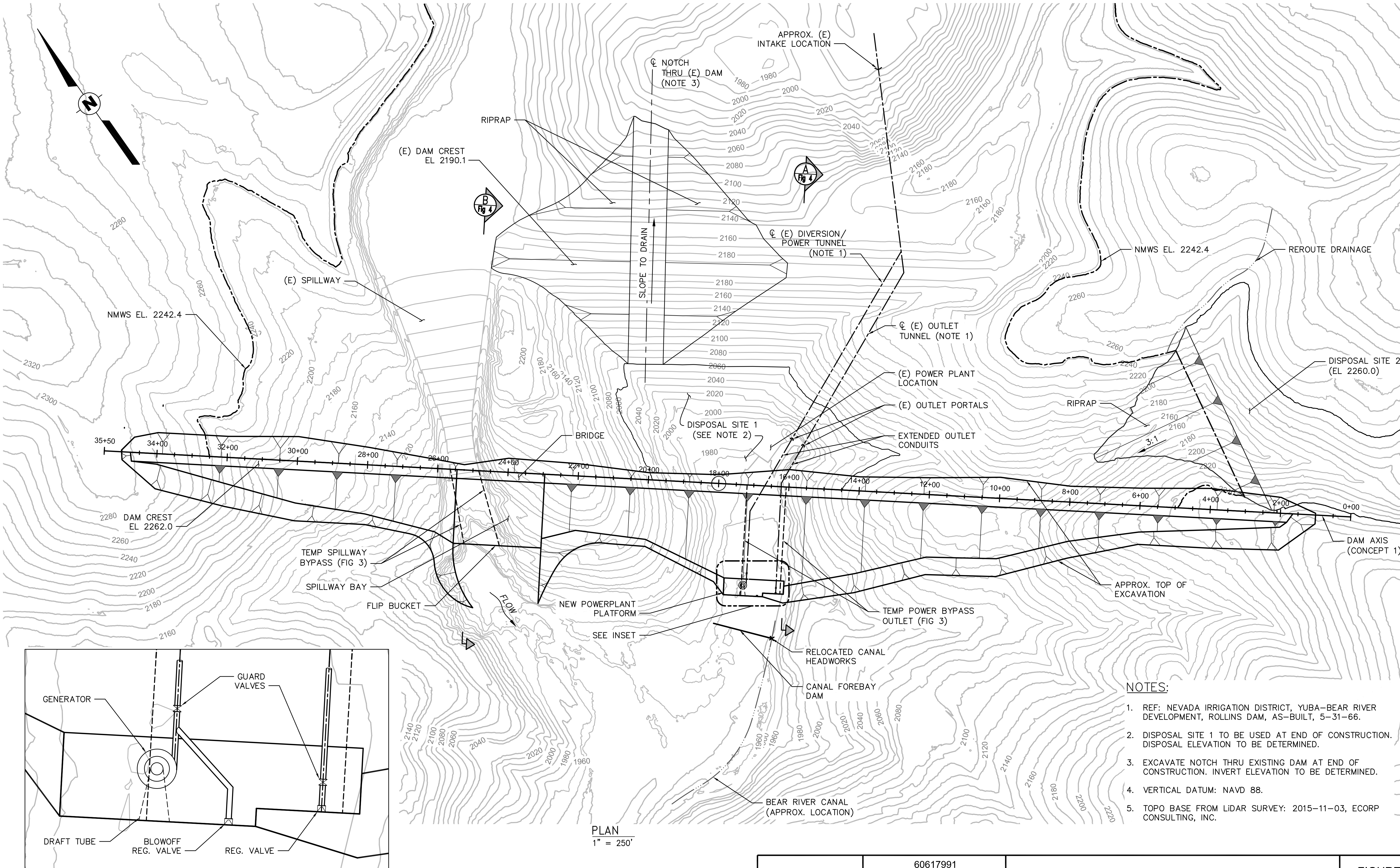


AECOM
Nevada Irrigation District
60617991

FIGURE 1
Site Vicinity Map - Rollins Reservoir



PLAN
1" = 250'

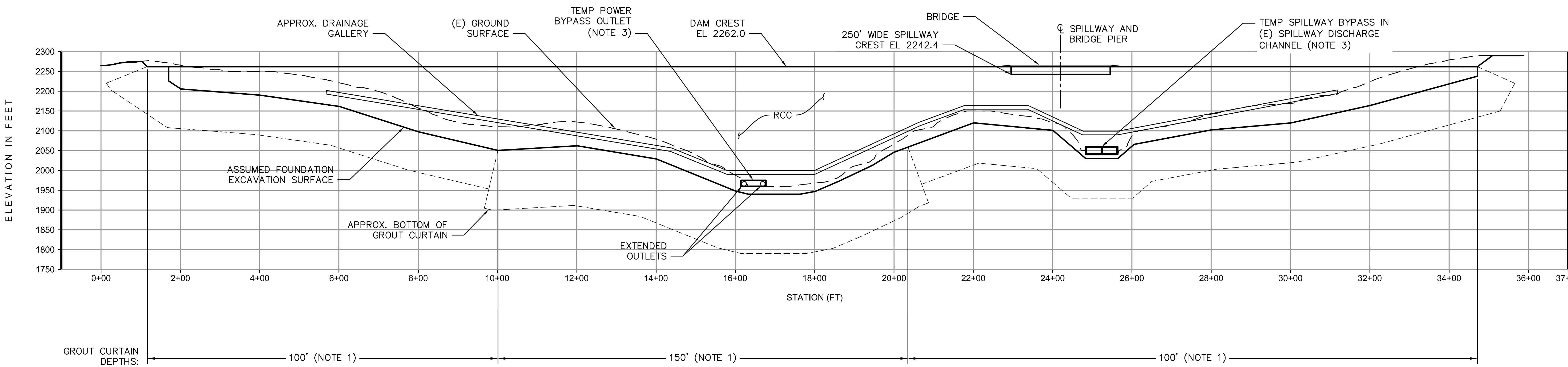
PLAN INSET
NTS

0 250 500 Feet

NOTES:

1. REF: NEVADA IRRIGATION DISTRICT, YUBA-BEAR RIVER DEVELOPMENT, ROLLINS DAM, AS-BUILT, 5-31-66.
2. DISPOSAL SITE 1 TO BE USED AT END OF CONSTRUCTION. DISPOSAL ELEVATION TO BE DETERMINED.
3. EXCAVATE NOTCH THRU EXISTING DAM AT END OF CONSTRUCTION. INVERT ELEVATION TO BE DETERMINED.
4. VERTICAL DATUM: NAVD 88.
5. TOPO BASE FROM LiDAR SURVEY: 2015-11-03, ECORP CONSULTING, INC.

AECOM	60617991 NEVADA IRRIGATION DISTRICT ENLARGED ROLLINS RESERVOIR CONCEPTS	RCC DAM CONCEPT 1 PLAN OF DAM	FIGURE 2



PROFILE ALONG DAM AXIS (LOOKING DOWNSTREAM)
1" = 250'

NOTES:

1. GROUT CURTAIN DEPTHS ARE PERPENDICULAR TO FOUNDATION SURFACE.
2. VERTICAL DATUM: NAVD 88.
3. FILL TEMPORARY BYPASSES WITH CONCRETE UPON COMPLETION OF CONSTRUCTION, AND PRIOR TO RESERVOIR FILLING.

0 250 500 Feet

AECOM

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NEVADA IRRIGATION DISTRICT
ENLARGED ROLLINS RESERVOIR CONCEPTS

RCC DAM CONCEPT 1
DAM AXIS PROFILE

FIGURE 3

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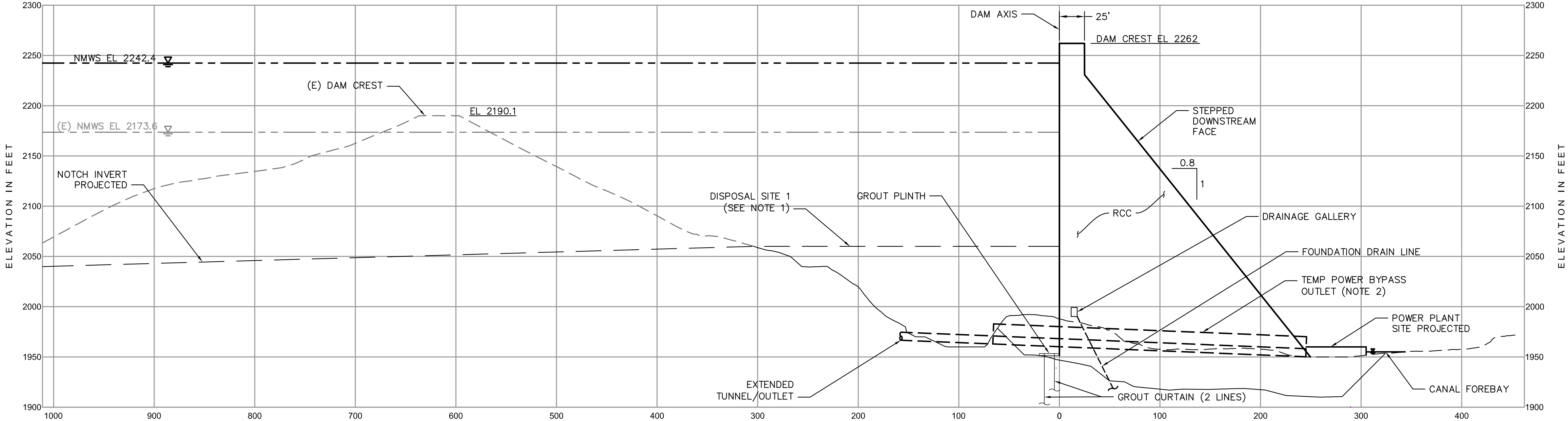
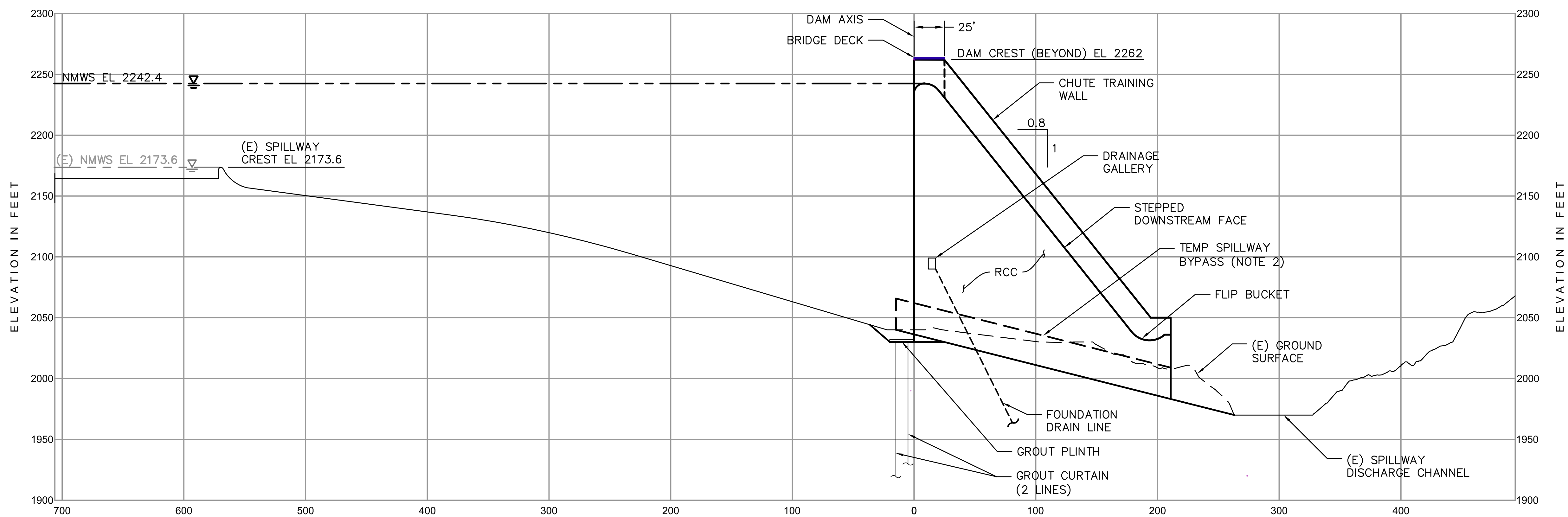
\\Oakland.na.aecomnet.com\Oakland\Projects\Legacy\IE_Xdrive\x_water\NID Parker Dam\14_Environmental\Alternative Projects\Enlarged Rollins_Added 80TAF\CADD\DESIGN\DESIGN-1D.dwg



SECTION @ STA. 16+00 (A / Fig 2)
1" = 100'



SECTION @ STA. 25+00 (B / Fig 2)
1" = 100'

NOTES:

1. DISPOSAL SITE 1 TO BE USED AT END OF CONSTRUCTION. DISPOSAL ELEVATION TO BE DETERMINED.
2. TEMPORARY BYPASSES TO BE FILLED WITH CONCRETE AT END OF CONSTRUCTION.
3. VERTICAL DATUM: NAVD 88.

0 100 200 Feet

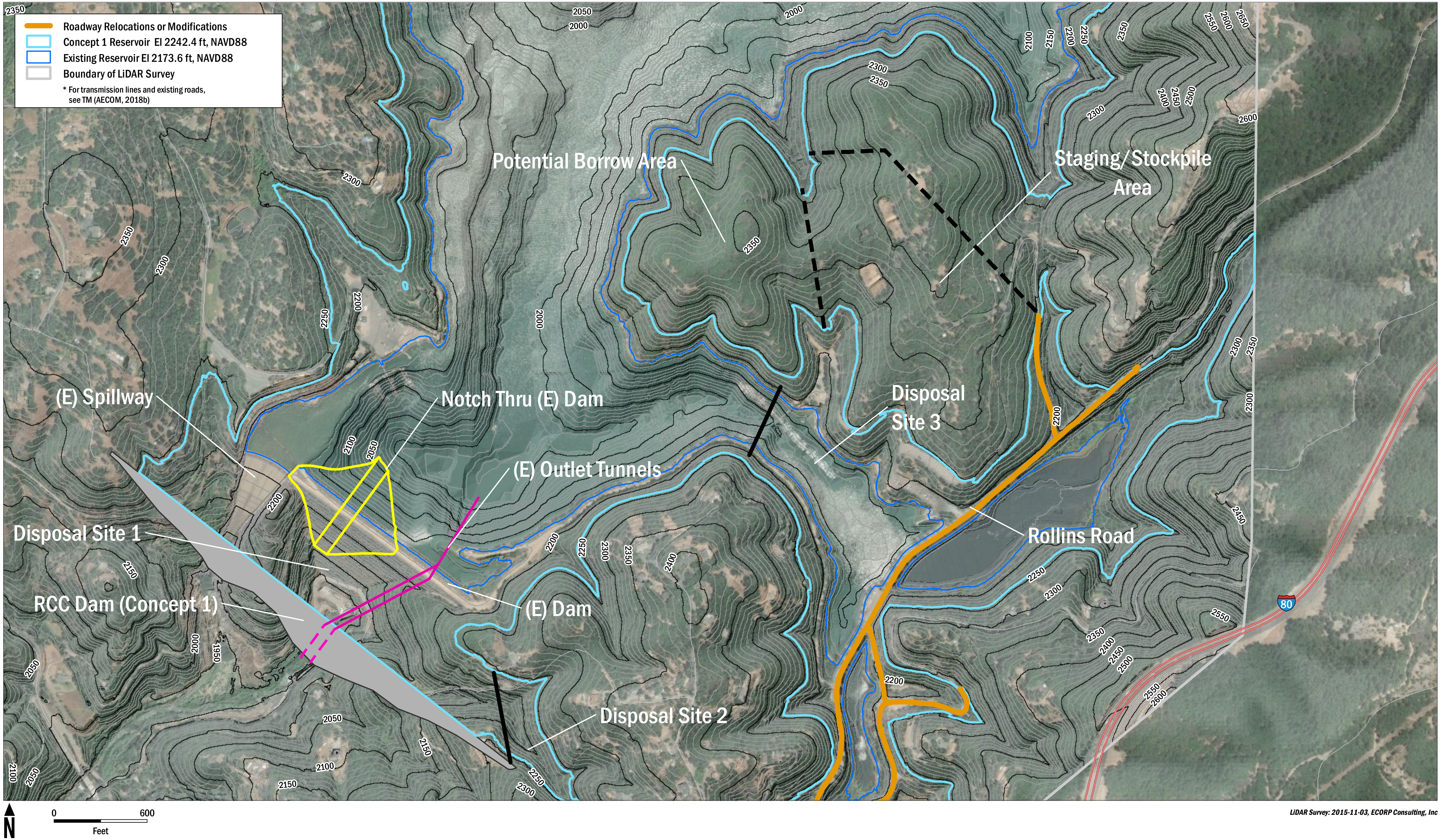
AECOM

60617991

NEVADA IRRIGATION DISTRICT
ENLARGED ROLLINS RESERVOIR CONCEPTS

RCC DAM CONCEPT 1
RCC DAM SECTIONS

FIGURE 4



LiDAR Survey: 2015-11-03, ECORP Consulting, Inc

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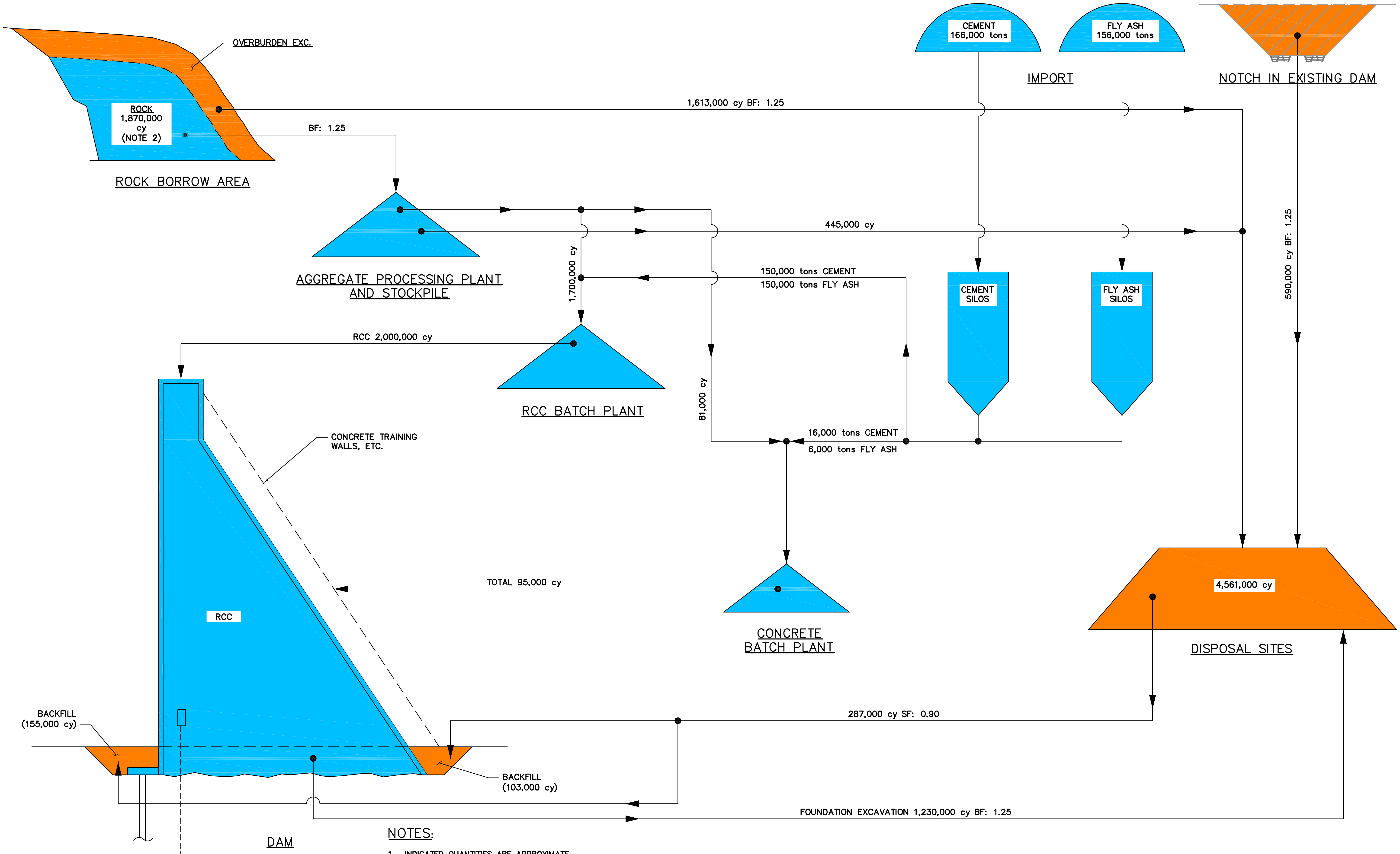
FIGURE 5
RCC Dam Concept 1
Site Area



NOTES:

1. INDICATED QUANTITIES ARE APPROXIMATE.
2. ROCK TO BE QUARRIED IS BASED ON REQUIRED AGGREGATE IN-PLACE IN DAM, WITH 25% BULK FACTOR PLUS 25% WASTE.
3. VOLUMES SHOWN ON THE ARROWS ARE PRIOR TO APPLYING THE BF OR SF.

BF = BULK FACTOR
SF = SHRINK FACTOR

AECOM	60617991 NEVADA IRRIGATION DISTRICT ENLARGED ROLLINS RESERVOIR CONCEPTS	RCC DAM CONCEPT 1 MATERIAL BALANCE DIAGRAM (CONCEPTUAL)	FIGURE 6

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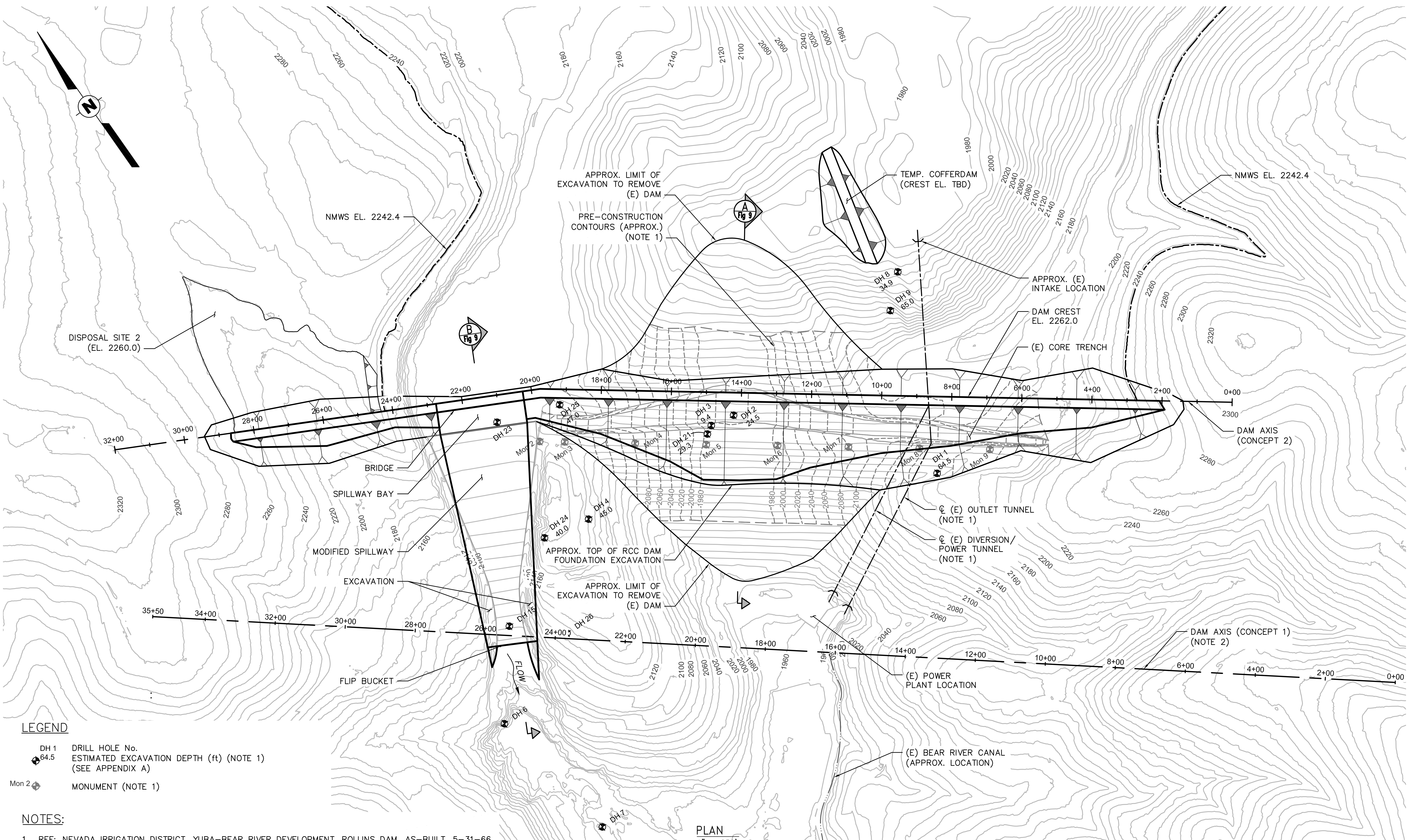


LEGEND

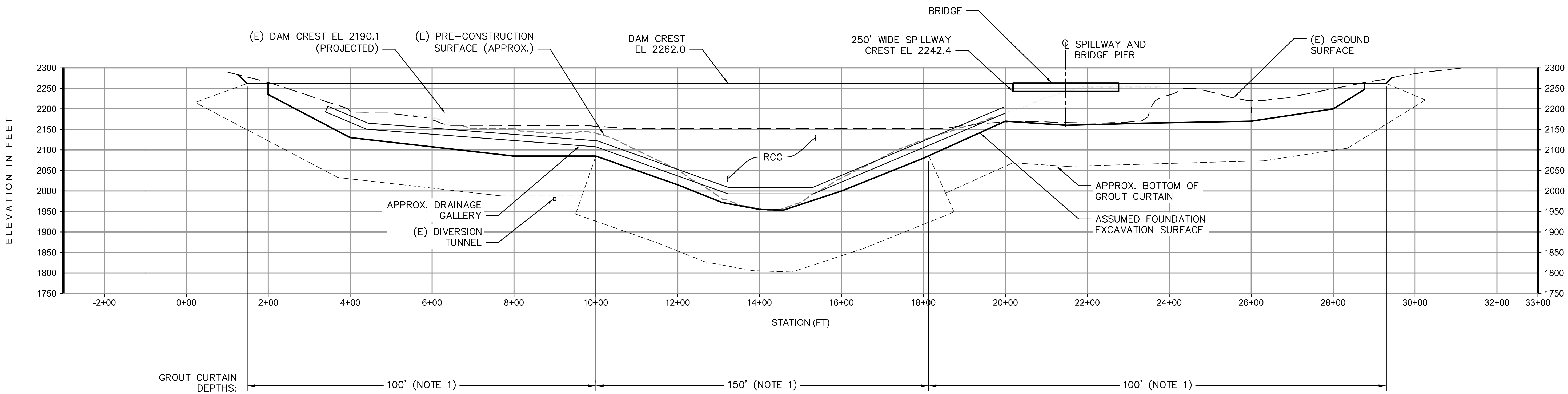
DH 1 64.5 — DRILL HOLE No. ESTIMATED EXCAVATION DEPTH (ft) (NOTE 1) (SEE APPENDIX A)

Mon 2 — MONUMENT (NOTE 1)

NOTES:

1. REF: NEVADA IRRIGATION DISTRICT, YUBA–BEAR RIVER DEVELOPMENT, ROLLINS DAM, AS-BUILT, 5–31–66.
2. REFER TO FIGURE 2.
3. VERTICAL DATUM: NAVD 88.
4. TOPO BASE FROM LiDAR SURVEY: 2015-11-03, ECORP CONSULTING, INC.

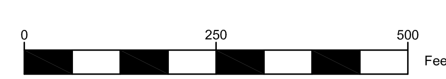
AECOM	60617991 NEVADA IRRIGATION DISTRICT ENLARGED ROLLINS RESERVOIR CONCEPTS	RCC DAM CONCEPT 2 PLAN OF DAM	FIGURE 7



PROFILE ALONG DAM AXIS (LOOKING DOWNSTREAM)
1" = 250'

NOTES:

1. GROUT CURTAIN DEPTHS ARE PERPENDICULAR TO FOUNDATION SURFACE.
2. VERTICAL DATUM: NAVD 88.



AECOM	60617991 NEVADA IRRIGATION DISTRICT ENLARGED ROLLINS RESERVOIR CONCEPTS	RCC DAM CONCEPT 2 DAM AXIS PROFILE	FIGURE 8

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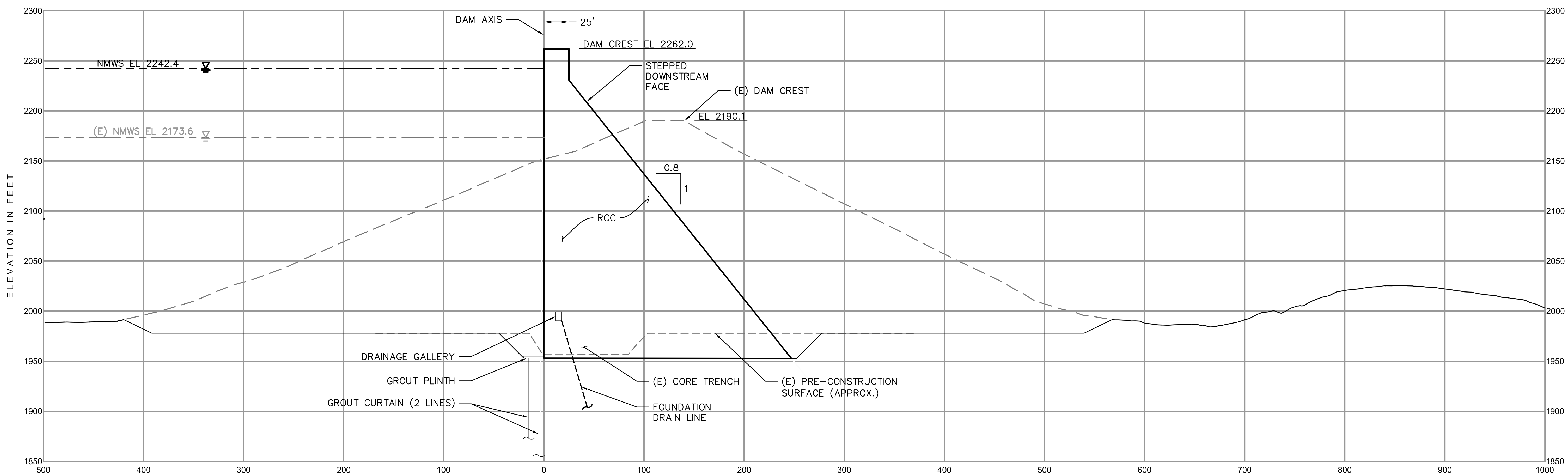
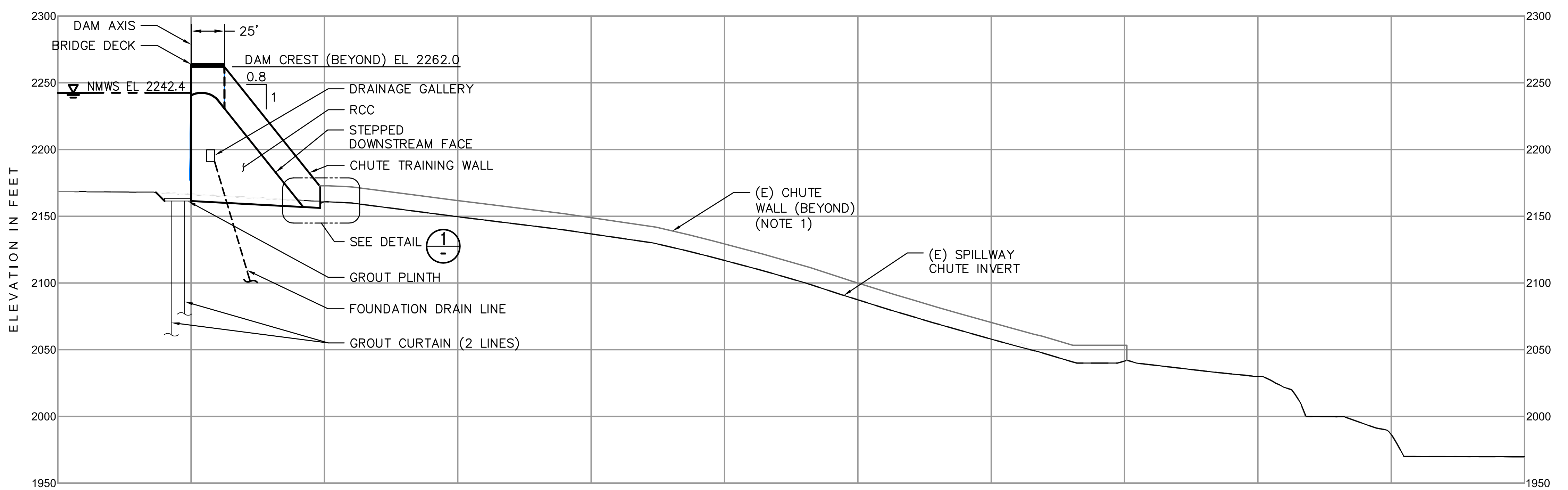
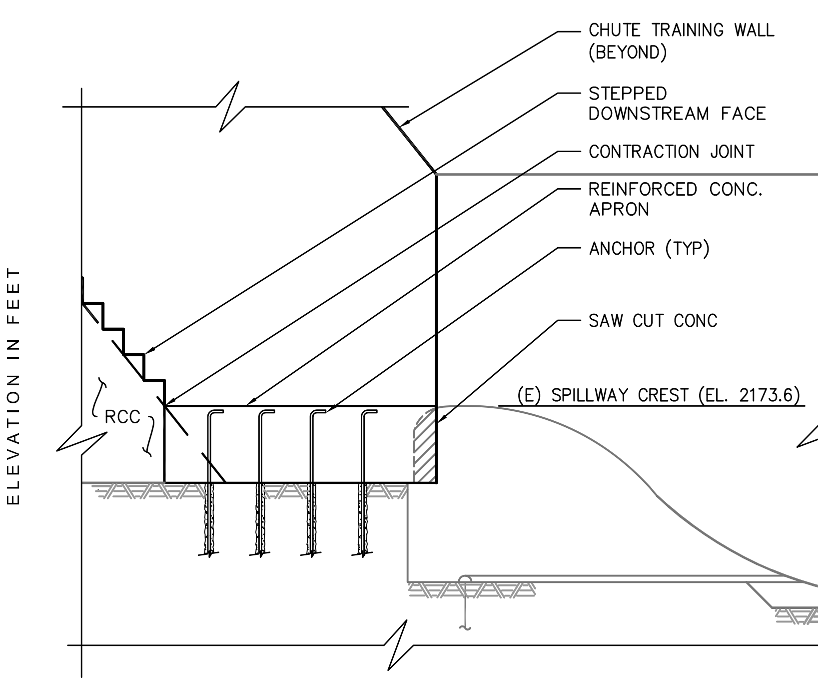


SECTION @ STA. 14+00 (A / Fig 7)
1" = 100'





DETAIL 1/–
N.T.S.

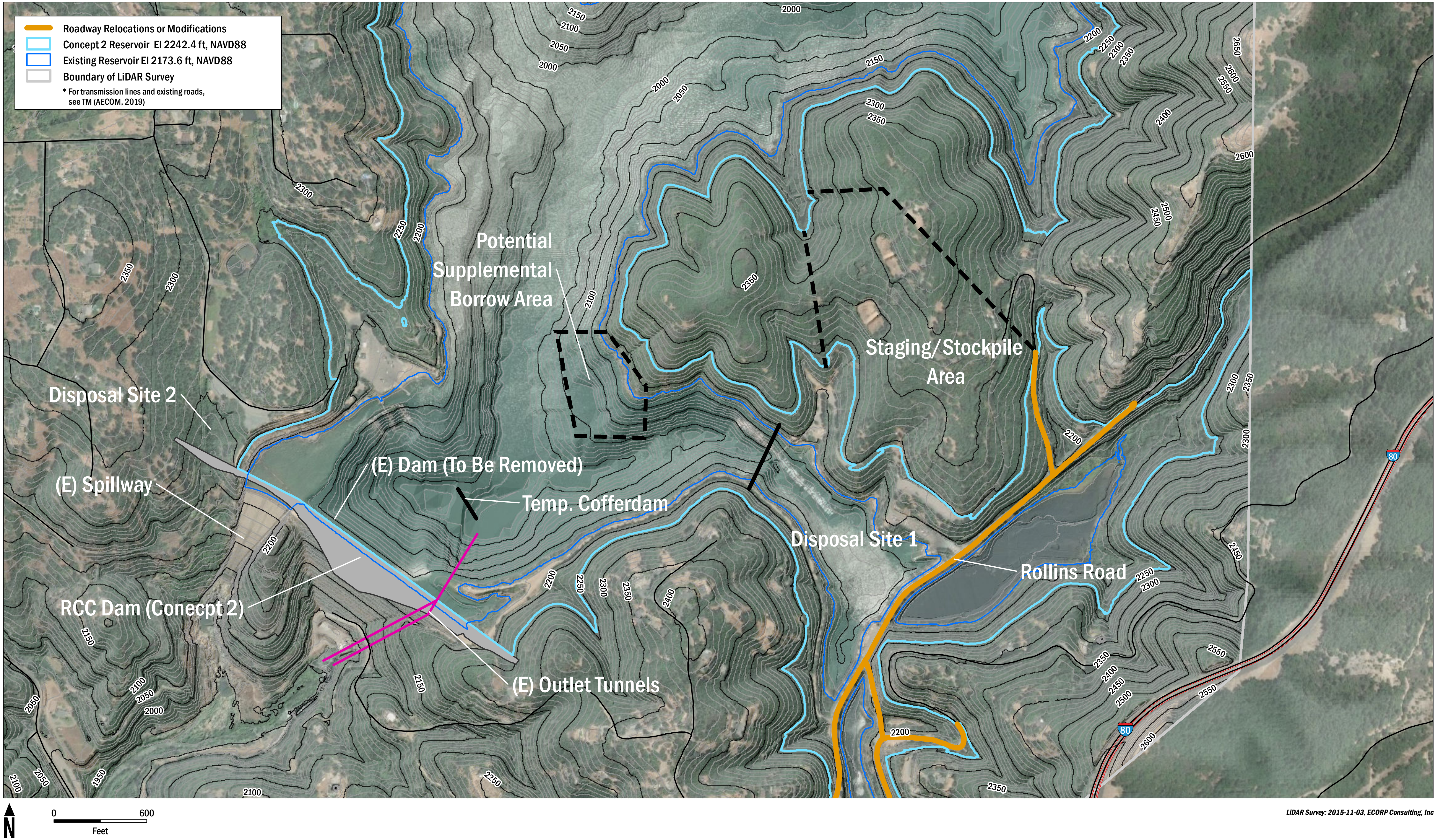
SECTION @ STA. 21+50 (B / Fig 7)
1" = 100'

NOTES:

1. ADEQUACY OF EXISTING SPILLWAY TO BE DETERMINED. (SEE DRAFT TECH MEMO, AECOM, 5/20/19).
2. VERTICAL DATUM: NAVD 88.

0 100 200 Feet

AECOM	60617991 NEVADA IRRIGATION DISTRICT ENLARGED ROLLINS RESERVOIR CONCEPTS	RCC DAM CONCEPT 2 RCC DAM SECTIONS	FIGURE 9



LiDAR Survey: 2015-11-03, ECORP Consulting, Inc

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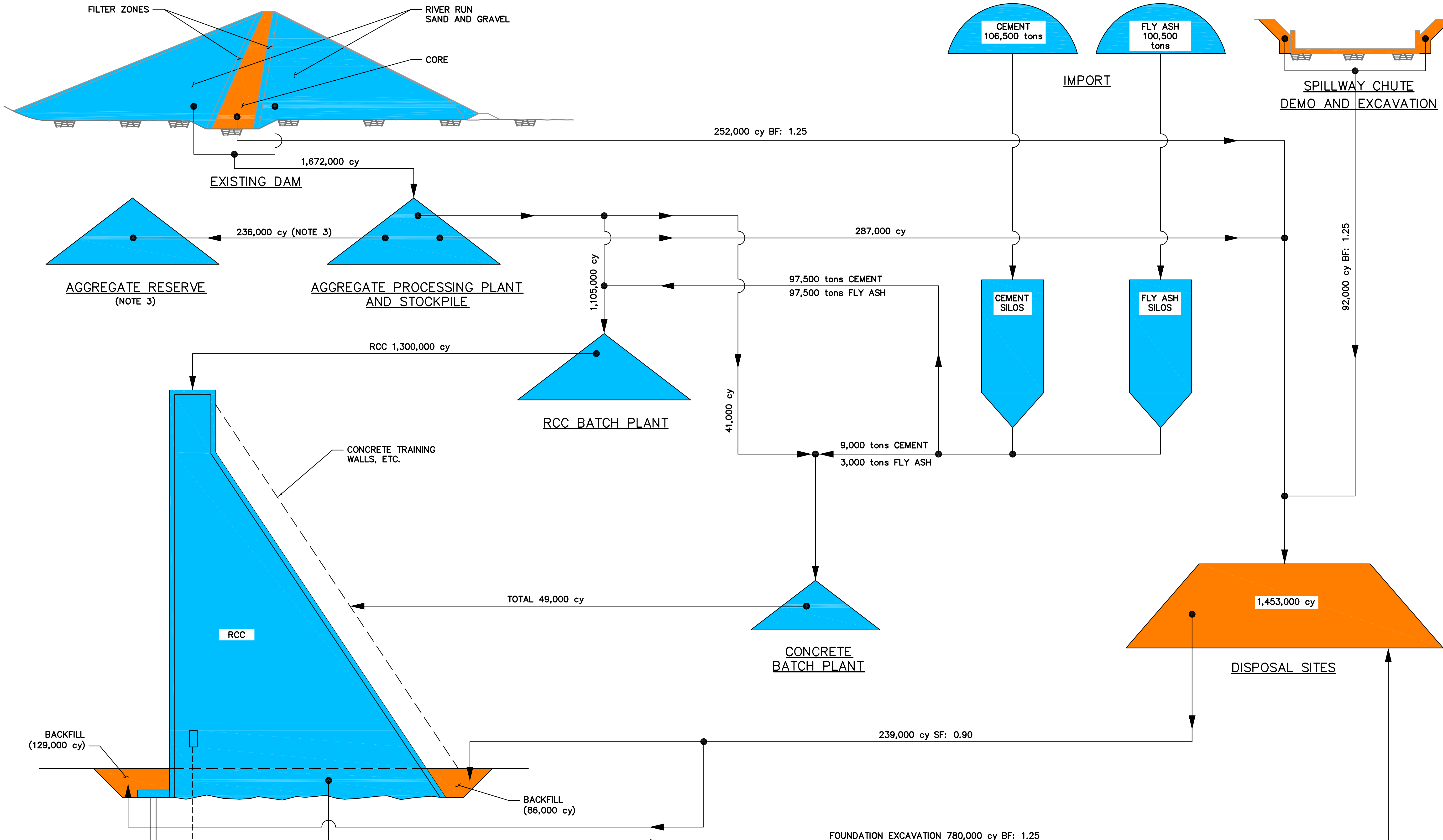
Nevada Irrigation District
60617991

FIGURE 10
RCC Dam Concept 2
Site Area

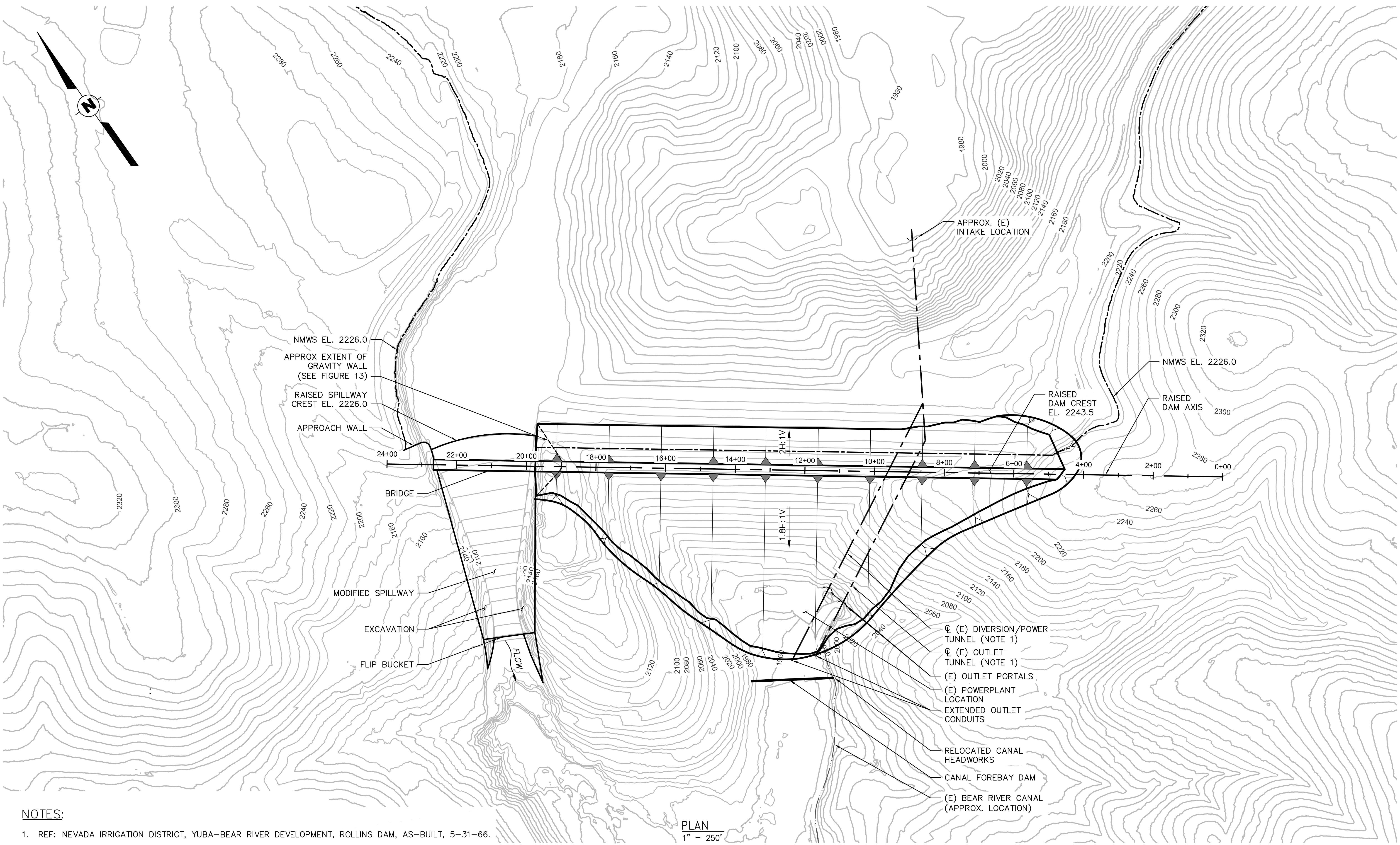


NOTES:

1. INDICATED QUANTITIES ARE APPROXIMATE.
2. ROCK TO BE QUARRIED IS BASED ON REQUIRED AGGREGATE IN-PLACE IN DAM, WITH 25% WASTE.
3. PLAN FOR GREATER RESERVE.
4. VOLUMES SHOWN ON THE ARROWS ARE PRIOR TO APPLYING THE BF OR SF.

BF = BULK FACTOR
SF = SHRINK FACTOR

AECOM	60617991 NEVADA IRRIGATION DISTRICT ENLARGED ROLLINS RESERVOIR CONCEPTS	RCC DAM CONCEPT 2 MATERIAL BALANCE DIAGRAM (CONCEPTUAL)	FIGURE 11



NOTES:

1. REF: NEVADA IRRIGATION DISTRICT, YUBA–BEAR RIVER DEVELOPMENT, ROLLINS DAM, AS-BUILT, 5–31–66.
2. VERTICAL DATUM: NAVD 88.
3. TOPO BASE FROM LiDAR SURVEY: 2015-11-03, ECORP CONSULTING, INC.

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NEVADA IRRIGATION DISTRICT
ENLARGED ROLLINS RESERVOIR
CONCEPTS

EMBANKMENT DAM RAISE CONCEPT
PLAN OF DAM

FIGURE
12

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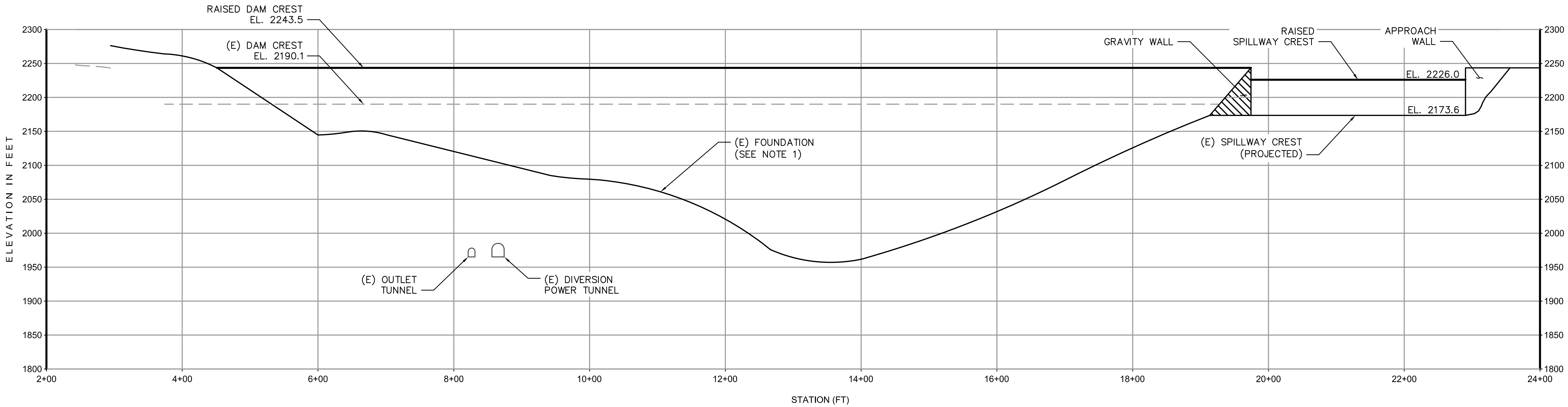

PROFILE ALONG DAM AXIS (LOOKING DOWNSTREAM)
1" = 150'

NOTES:

1. PROFILE IS ALONG EXISTING DAM CORE TRENCH, PROJECTED ONTO THIS SECTION.
2. VERTICAL DATUM: NAVD 88.

0 150 300 Feet

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60617991

NEVADA IRRIGATION DISTRICT
ENLARGED ROLLINS RESERVOIR
CONCEPTS

EMBANKMENT DAM RAISE CONCEPT
DAM AXIS PROFILE

FIGURE
13

Jan 07, 2020 - 3:19pm
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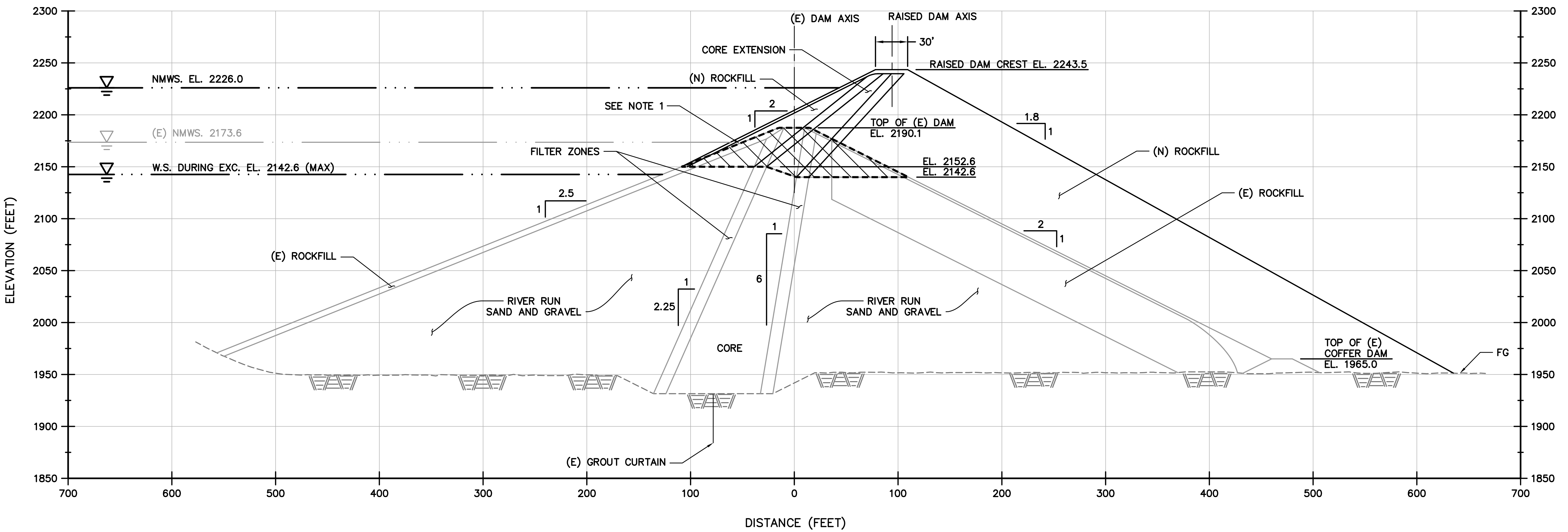


SECTION
1" = 100'

NOTES:

1. EXCAVATE EXISTING DAM CREST AND REPLACE FOR INTERIM DAM, ONE SEASON CONSTRUCTION.
2. VERTICAL DATUM: NAVD 88.

0 100 200 Feet

AECOM

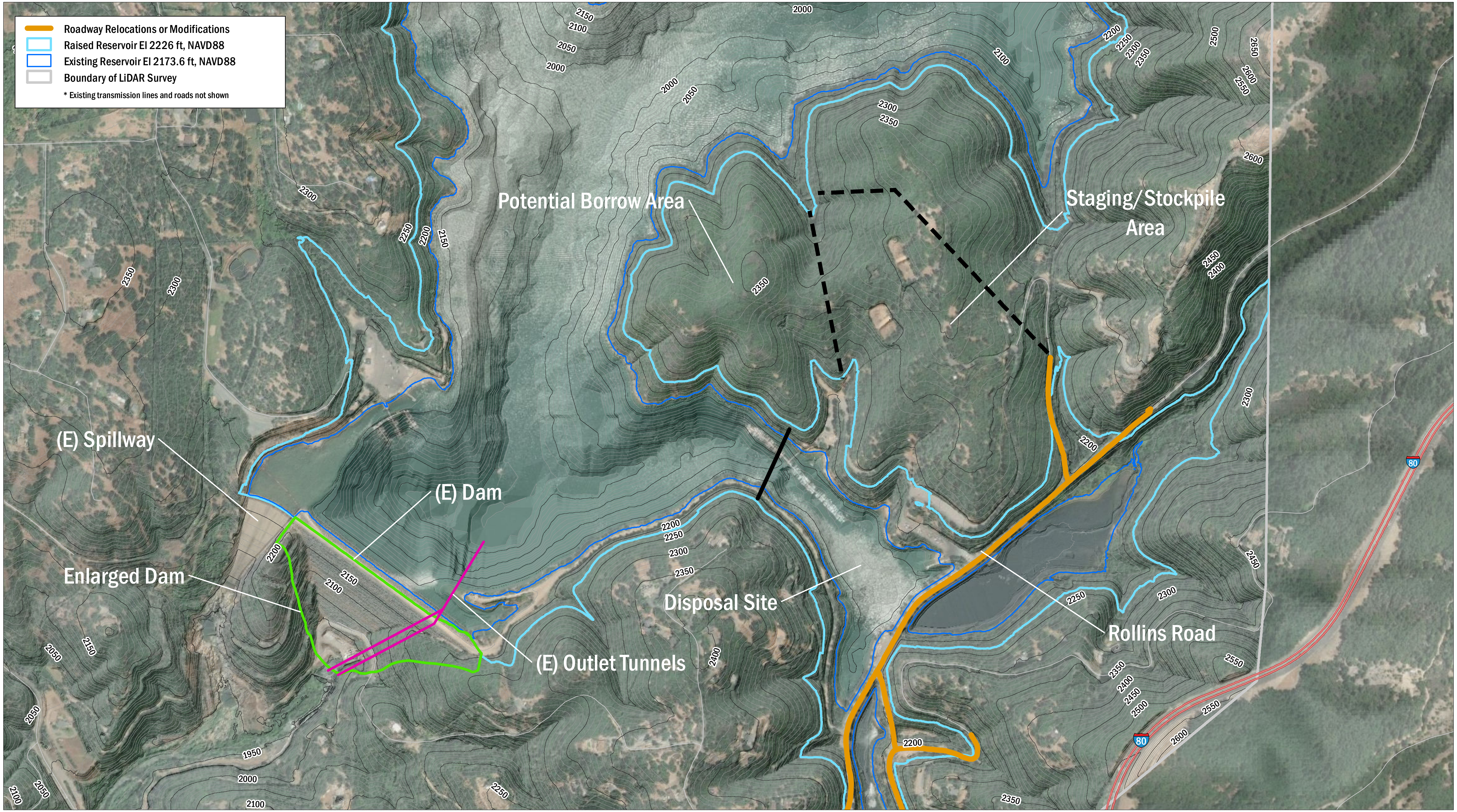
60617991

NEVADA IRRIGATION DISTRICT
ENLARGED ROLLINS RESERVOIR
CONCEPTS

EMBANKMENT DAM RAISE CONCEPT
MAXIMUM SECTION

FIGURE
14

AECOM Oakland CA 1/7/2020 USER Ryan.Haines PATH L:\Projects\GIS\Projects\NID_Rollins_Reservoir\02_Maps\02_Map_Production_and_Reports\EnlargedRollinsRes_CostEst_Figs\Figure_15_Enlarged_Rollins_Reservoir_Embankment_Dam_Raise_Concept.mxd



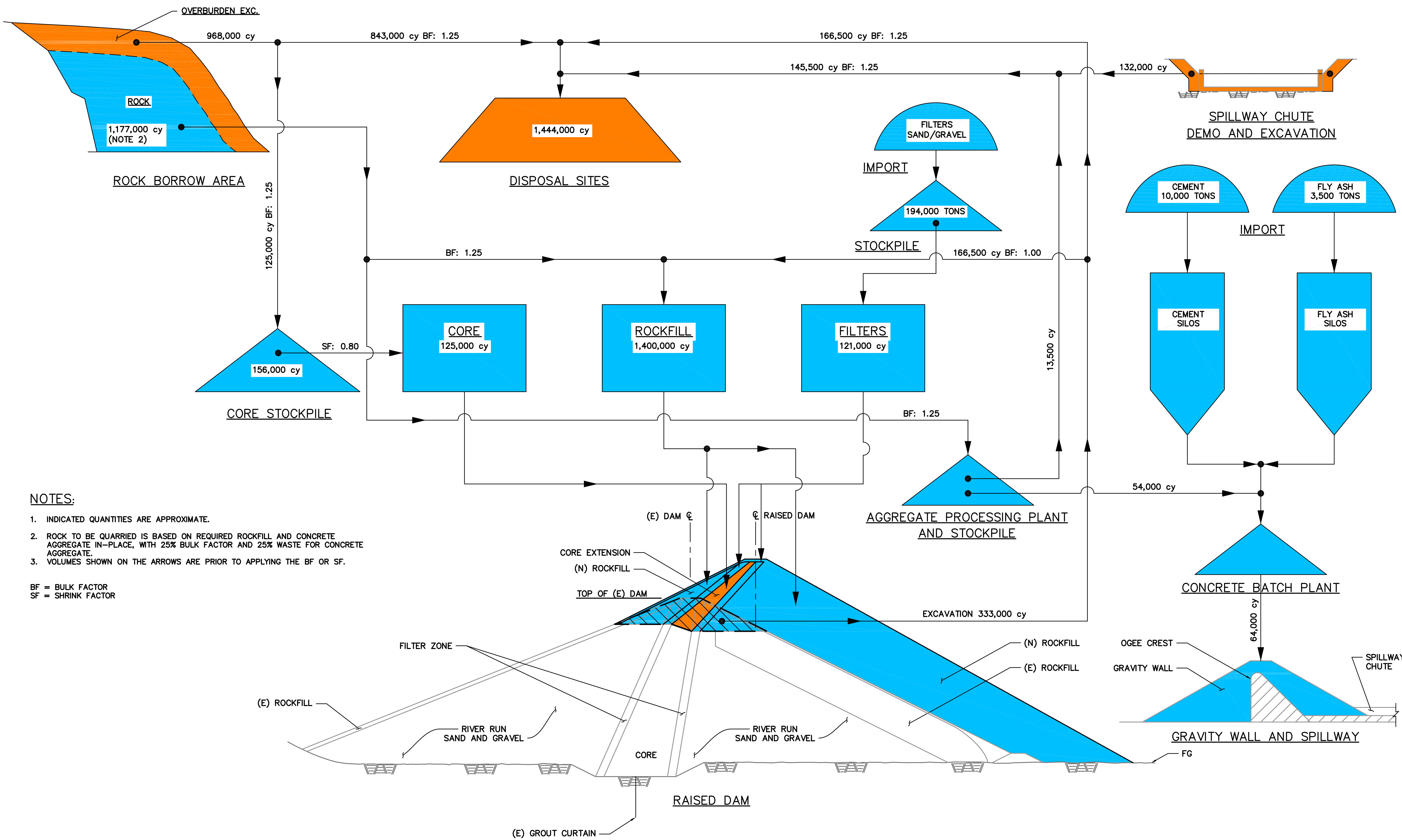
N

0 600
Feet

LiDAR Survey: 2015-11-03, ECORP Consulting, Inc

AECOM
Nevada Irrigation District
60617991

FIGURE 15
Embankment Dam Raise Concept
Site Area



NOTES:

1. INDICATED QUANTITIES ARE APPROXIMATE.
2. ROCK TO BE QUARRIED IS BASED ON REQUIRED ROCKFILL AND CONCRETE AGGREGATE IN-PLACE, WITH 25% BULK FACTOR AND 25% WASTE FOR CONCRETE AGGREGATE.
3. VOLUMES SHOWN ON THE ARROWS ARE PRIOR TO APPLYING THE BF OR SF.

BF = BULK FACTOR
SF = SHRINK FACTOR

AECOM	60617991 NEVADA IRRIGATION DISTRICT ENLARGED ROLLINS RESERVOIR CONCEPTS	EMBANKMENT DAM RAISE CONCEPT MATERIAL BALANCE DIAGRAM (CONCEPTUAL)	FIGURE 16

Appendix A.
Opinions of Probable Construction Costs for Conceptual Rollins Reservoir Enlargements

NID ROLLINS RESERVOIR - RCC DAM CONCEPT 1

Opinion of Probable Construction Cost (AACE Class 4)

Base Year: 2017

Axis: Rollins Site 1

Category/Item (WBS) No.	Description	Est. Pay Quantity	Units	Unit Price	Extension	% Contingency	Contingency Amount	Extension + Contingency	Line Item % of Total	Category Total	Category % of Total
A	Mobilization & Demobilization				$ 42,681,225	0%	$ -	$ 42,681,225		$ 42,681,225	7.1%
1	Mobilization & demobilization	1	LS	$ 42,681,225	$ 42,681,225	0.0%	$ -	$ 42,681,225	7.1%		
B	Site Development				$ 32,956,000	34.8%	$ 11,484,600	$ 44,440,600		$ 44,440,600	7.4%
2	Site preparation	1	LS	$ 1,000,000	$ 1,000,000	30.0%	$ 300,000	$ 1,300,000	0.2%		
3	Borrow area stripping	1,613,000	cy	$ 10.50	$ 16,936,500	35.0%	$ 5,927,775	$ 22,864,275	3.8%		
4	Quarry drill & blast	1,767,000	cy	$ 8.50	$ 15,019,500	35.0%	$ 5,256,825	$ 20,276,325	3.4%		
C	River Diversion				$ 1,500,000	30%	$ 450,000	$ 1,950,000		$ 1,950,000	0.3%
5	Diversion during construction	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.1%		
6	Cofferdams - upstream & downstream	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.1%		
7	Dewatering	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.1%		
D	Dam Foundation				$ 69,637,650	30%	$ 20,574,848	$ 90,212,498		$ 90,212,498	15.1%
8.1	Foundation excavation - common	922,500	cy	$ 11.00	$ 10,147,500	35.0%	$ 3,551,625	$ 13,699,125	2.3%		
8.2	Foundation excavation - rock	307,500	cy	$ 21.50	$ 6,611,250	35.0%	$ 2,313,938	$ 8,925,188	1.5%		
9	Initial cleaning	62,100	sy	$ 20.00	$ 1,242,000	20.0%	$ 248,400	$ 1,490,400	0.2%		
10	Final cleaning	62,100	sy	$ 20.00	$ 1,242,000	20.0%	$ 248,400	$ 1,490,400	0.2%		
11	Surface preparation (includes dental concrete)	62,100	sy	$ 25.00	$ 1,552,500	25.0%	$ 388,125	$ 1,940,625	0.3%		
12	Levelling concrete	37,260	cy	$ 280.00	$ 10,432,800	30.0%	$ 3,129,840	$ 13,562,640	2.3%		
13	Grout curtains (825 holes; cement @ 0.35 lb/lf)	95,500	lf	$ 155.00	$ 14,802,500	35.0%	$ 5,180,875	$ 19,983,375	3.3%		
14	Structural concrete - grouting plinth	9,200	cy	$ 1,230.00	$ 11,316,000	20.0%	$ 2,263,200	$ 13,579,200	2.3%		
15	Grouting plinth - anchors (fully grouted, 20' long, #9 bars)	13,200	lf	$ 205.00	$ 2,706,000	20.0%	$ 541,200	$ 3,247,200	0.5%		
16	Consolidation grouting (30' deep; 1680 holes; cement @ 0.35 lb/lf)	50,300	lf	$ 105.00	$ 5,281,500	35.0%	$ 1,848,525	$ 7,130,025	1.2%		
17	Drain holes (330 holes)	37,100	lf	$ 116.00	$ 4,303,600	20.0%	$ 860,720	$ 5,164,320	0.9%		
E	RCC, Facing Concrete & Gallery				$ 268,800,000	30%	$ 80,640,000	$ 349,440,000		$ 349,440,000	58.5%
18	RCC, facing concrete & gallery	2,000,000	cy	$ 108.00	$ 216,000,000	30.0%	$ 64,800,000	$ 280,800,000	47.0%		
19	Cement for RCC - Type II	150,000	ton	$ 210.00	$ 31,500,000	30.0%	$ 9,450,000	$ 40,950,000	6.9%		
20	Class F fly ash for RCC	150,000	ton	$ 142.00	$ 21,300,000	30.0%	$ 6,390,000	$ 27,690,000	4.6%		
F	Spillway & Dam Crest				$ 14,057,300	22%	$ 3,044,925	$ 17,102,225		$ 17,102,225	2.9%
21	Spillway walls (reinforced concrete)	510	cy	$ 1,230.00	$ 627,300	25.0%	$ 156,825	$ 784,125	0.1%		
22	Spillway crest	1,950	cy	$ 1,000.00	$ 1,950,000	25.0%	$ 487,500	$ 2,437,500	0.4%		
23	Crest slab	3,100	cy	$ 740.00	$ 2,294,000	15.0%	$ 344,100	$ 2,638,100	0.4%		
24	Parapet walls (reinforced concrete)	1,280	cy	$ 1,250.00	$ 1,600,000	10.0%	$ 160,000	$ 1,760,000	0.3%		
25	Temp. spillway bypass (reinforced concrete)	3,200	cy	$ 1,230.00	$ 3,936,000	25.0%	$ 984,000	$ 4,920,000	0.8%		
26	Plug temp. spillway bypass (mass concrete)	7,300	cy	$ 500.00	$ 3,650,000	25.0%	$ 912,500	$ 4,562,500	0.8%		

G	Spillway Bridge				$ 2,137,500	30%	$ 641,250	$ 2,778,750		$ 2,778,750	0.5%
27	Deck & pier	4,750	sf	$ 450.00	$ 2,137,500	30%	$ 641,250	$ 2,778,750	0.5%		
H	Outlet & Intake Structures & Pipe				$ 22,646,000	31%	$ 6,990,100	$ 29,636,100		$ 29,636,100	5.0%
28	New Outlet structure (reinforced concrete)	1	LS	$ 2,500,000	$ 2,500,000	40.0%	$ 1,000,000	$ 3,500,000	0.6%		
29	Temp. power bypass (reinforced concrete)	5,800	cy	$ 1,230.00	$ 7,134,000	30.0%	$ 2,140,200	$ 9,274,200	1.6%		
30	Plug temp. power bypass (mass concrete)	14,200	cy	$ 500.00	$ 7,100,000	30.0%	$ 2,130,000	$ 9,230,000	1.5%		
31	Steel outlet pipe extensions (8' dia.)	300	lf	$ 3,040.00	$ 912,000	20.0%	$ 182,400	$ 1,094,400	0.2%		
32	Intake/trashrack	1	LS	$ 750,000	$ 750,000	35.0%	$ 262,500	$ 1,012,500	0.2%		
33	Mechanical (gates, valves, actuators, ventilation)	1	LS	$ 3,000,000	$ 3,000,000	30.0%	$ 900,000	$ 3,900,000	0.7%		
34	Electrical controls and lighting	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.2%		
35	Canal forebay dam & headworks	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.1%		
I	Misc. Civil				$ 13,377,800	24%	$ 3,157,840	$ 16,535,640		$ 16,535,640	2.8%
36	Backfill	257,000	cy	$ 10.40	$ 2,672,800	30.0%	$ 801,840	$ 3,474,640	0.6%		
37	Roadways (paved)	1	LS	$ 250,000	$ 250,000	30.0%	$ 75,000	$ 325,000	0.1%		
38	Excavate notch in existing dam	590,000	cy	$ 14.50	$ 8,555,000	20.0%	$ 1,711,000	$ 10,266,000	1.7%		
39	Gallery portals	1	LS	$ 250,000	$ 250,000	30.0%	$ 75,000	$ 325,000	0.1%		
40	Heavy riprap (on-site borrow)	5,000	cy	$ 60.00	$ 300,000	30.0%	$ 90,000	$ 390,000	0.1%		
41	Site Restoration	120	Acres	$ 5,000	$ 600,000	30.0%	$ 180,000	$ 780,000	0.1%		
42	Forebay & canal headworks	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.2%		
J	Instrumentation & SCADA				$ 1,700,000	30%	$ 510,000	$ 2,210,000		$ 2,210,000	0.4%
43	Instrumentation & ADAS	1	LS	$ 850,000	$ 850,000	30.0%	$ 255,000	$ 1,105,000	0.2%		
44	SCADA	1	LS	$ 850,000	$ 850,000	30.0%	$ 255,000	$ 1,105,000	0.2%		
Total Estimated Construction Cost (2017 dollars)					$ 469,493,475		$ 127,493,563	$ 596,987,038	100.0%	$ 596,987,038	100.0%
Overall Design Contingency						27.2%		$ 596,987,038			
Note: See Tech Memo for cost exclusions.									Q2 2017	Q4 2019*	Cost per AF
							Opinion of Probable Construction Cost		$ 597,000,000	$ 644,800,000	$ 8,060
							Estimated Range - Low (-20%)		$ 477,600,000	$ 515,800,000	$ 6,448
							Estimated Range - High (+20%)		$ 716,400,000	$ 773,700,000	$ 9,671
							Storage Increase (AF)				80,000
							* 8% escalation				

NID ROLLINS RESERVOIR - RCC DAM CONCEPT 2											
Opinion of Probable Construction Cost (AACE Class 4)											
Base Year:	2017										
Axis:	Rollins Site 2										
Category/Item (WBS) No.	**Description**	**Est. Pay Quantity**	**Units**	**Unit Price**	**Extension**	**% Contingency**	**Contingency Amount**	**Extension + Contingency**	**Line Item % of Total**	**Category Total**	**Category % of Total**
A	Mobilization & Demobilization				$ 30,367,430	0%	$ -	$ 30,367,430		$ 30,367,430	7.2%
1	Mobilization & demobilization	1	LS	$ 30,367,430	$ 30,367,430	0.0%	$ -	$ 30,367,430	7.2%		
B	Site Development				$ 15,880,800	34.7%	$ 5,508,280	$ 21,389,080		$ 21,389,080	5.1%
2	Site preparation	1	LS	$ 1,000,000	$ 1,000,000	30.0%	$ 300,000	$ 1,300,000	0.3%		
3	Borrow area stripping (NA)	-	cy	$ 10.50	$ -	35.0%	$ -	$ -	0.0%		
4.1	Quarry drill & blast (NA)	-	cy	$ 8.50	$ -	35.0%	$ -	$ -	0.0%		
4.2	Process Existing Dam Gravel for RCC Aggregate	1,672,000	cy	$ 8.90	$ 14,880,800	35.0%	$ 5,208,280	$ 20,089,080	4.8%		
C	River Diversion				$ 1,500,000	43%	$ 650,000	$ 2,150,000		$ 2,150,000	0.5%
5	Diversion during construction	1	LS	$ 500,000	$ 500,000	50.0%	$ 250,000	$ 750,000	0.2%		
6	Cofferdams - upstream & downstream	1	LS	$ 500,000	$ 500,000	50.0%	$ 250,000	$ 750,000	0.2%		
7	Dewatering	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.2%		
D	Dam Foundation				$ 70,320,400	26%	$ 18,563,865	$ 88,884,265		$ 88,884,265	21.1%
8.1	Foundation excavation - common	585,000	cy	$ 11.00	$ 6,435,000	35.0%	$ 2,252,250	$ 8,687,250	2.1%		
8.2	Foundation excavation - rock	195,000	cy	$ 21.50	$ 4,192,500	35.0%	$ 1,467,375	$ 5,659,875	1.3%		
8.3	Existing Dam (total volume, includes No. 4.2)	1,925,000	cy	$ 11.00	$ 21,175,000	20.0%	$ 4,235,000	$ 25,410,000	6.0%		
9	Initial cleaning	34,700	sy	$ 20.00	$ 694,000	20.0%	$ 138,800	$ 832,800	0.2%		
10	Final cleaning	34,700	sy	$ 20.00	$ 694,000	20.0%	$ 138,800	$ 832,800	0.2%		
11	Surface preparation (includes dental concrete)	34,700	sy	$ 25.00	$ 867,500	25.0%	$ 216,875	$ 1,084,375	0.3%		
12	Levelling concrete	20,820	cy	$ 280.00	$ 5,829,600	30.0%	$ 1,748,880	$ 7,578,480	1.8%		
13	Grout curtains (690 holes; cement @ 0.35 lb/lf)	79,000	lf	$ 155.00	$ 12,245,000	35.0%	$ 4,285,750	$ 16,530,750	3.9%		
14	Structural concrete - grouting plinth	7,650	cy	$ 1,230.00	$ 9,409,500	20.0%	$ 1,881,900	$ 11,291,400	2.7%		
15	Grouting plinth - anchors (fully grouted, 20' long, #9 bars)	11,000	lf	$ 205.00	$ 2,255,000	20.0%	$ 451,000	$ 2,706,000	0.6%		
16	Consolidation grouting (30' deep; 940 holes; cement @ 0.35 lb/lf)	28,100	lf	$ 105.00	$ 2,950,500	35.0%	$ 1,032,675	$ 3,983,175	0.9%		
17	Drain holes (275 holes)	30,800	lf	$ 116.00	$ 3,572,800	20.0%	$ 714,560	$ 4,287,360	1.0%		
E	RCC, Facing Concrete & Gallery				$ 174,720,000	30%	$ 52,416,000	$ 227,136,000		$ 227,136,000	53.8%
18	RCC, facing concrete & gallery	1,300,000	cy	$ 108.00	$ 140,400,000	30.0%	$ 42,120,000	$ 182,520,000	43.2%		
19	Cement for RCC - Type II	97,500	ton	$ 210.00	$ 20,475,000	30.0%	$ 6,142,500	$ 26,617,500	6.3%		
20	Class F fly ash for RCC	97,500	ton	$ 142.00	$ 13,845,000	30.0%	$ 4,153,500	$ 17,998,500	4.3%		
F	Spillway & Dam Crest				$ 26,292,600	24%	$ 6,292,400	$ 32,585,000		$ 32,585,000	7.7%
21	Spillway walls (reinforced concrete, on RCC dam)	220	cy	$ 1,230.00	$ 270,600	25.0%	$ 67,650	$ 338,250	0.1%		
22	Spillway crest (reinforced concrete, on RCC dam)	1,950	cy	$ 1,000.00	$ 1,950,000	25.0%	$ 487,500	$ 2,437,500	0.6%		
23	Demo existing slab & spillway walls (reinforced concrete)	7,500	cy	$ 450.00	$ 3,375,000	25.0%	$ 843,750	$ 4,218,750	1.0%		
24	Common excavation	42,500	cy	$ 15.00	$ 637,500	30.0%	$ 191,250	$ 828,750	0.2%		
25	Rock excavation	42,500	cy	$ 25.00	$ 1,062,500	30.0%	$ 318,750	$ 1,381,250	0.3%		
26	Foundation cleaning	14,000	sy	$ 20.00	$ 280,000	25.0%	$ 70,000	$ 350,000	0.1%		
27	Chute spillway concrete walls	1,000	cy	$ 1,230.00	$ 1,230,000	30.0%	$ 369,000	$ 1,599,000	0.4%		

28	Chute spillway invert slab	9,200	cy	$ 740.00	$ 6,808,000	30.0%	$ 2,042,400	$ 8,850,400	2.1%		
29	Crest slab	2,600	cy	$ 740.00	$ 1,924,000	15.0%	$ 288,600	$ 2,212,600	0.5%		
30	Parapet walls (reinforced concrete)	1,100	cy	$ 1,250.00	$ 1,375,000	10.0%	$ 137,500	$ 1,512,500	0.4%		
31	Anchors (fully grouted, 20' long, #9 bars)	36,000	lf	$ 205.00	$ 7,380,000	20.0%	$ 1,476,000	$ 8,856,000	2.1%		
G	Spillway Bridge				$ 2,137,500	30%	$ 641,250	$ 2,778,750		$ 2,778,750	0.7%
32	Deck & pier	4,750	sf	$ 450.00	$ 2,137,500	30%	$ 641,250	$ 2,778,750	0.7%		
H	Outlet & Intake Structures & Pipe				$ 7,912,000	32%	$ 2,569,900	$ 10,481,900		$ 10,481,900	2.5%
33	New outlet structure (reinforced concrete)	1	LS	$ 2,500,000	$ 2,500,000	40.0%	$ 1,000,000	$ 3,500,000	0.8%		
34	Steel outlet pipe (8' dia.)	300	lf	$ 3,040.00	$ 912,000	20.0%	$ 182,400	$ 1,094,400	0.3%		
35	Intake/trashrack	1	LS	$ 750,000	$ 750,000	35.0%	$ 262,500	$ 1,012,500	0.2%		
36	Mechanical (gates, valves, actuators, ventilation)	1	LS	$ 3,000,000	$ 3,000,000	30.0%	$ 900,000	$ 3,900,000	0.9%		
37	Electrical controls and lighting	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.2%		
I	Misc. Civil				$ 3,411,000	30%	$ 1,023,300	$ 4,434,300		$ 4,434,300	1.1%
38	Backfill	215,000	cy	$ 10.40	$ 2,236,000	30.0%	$ 670,800	$ 2,906,800	0.7%		
39	Roadways (paved)	1	LS	$ 250,000	$ 250,000	30.0%	$ 75,000	$ 325,000	0.1%		
40	Gallery portals	1	LS	$ 250,000	$ 250,000	30.0%	$ 75,000	$ 325,000	0.1%		
41	Heavy riprap (on-site borrow)	5,000	cy	$ 60.00	$ 300,000	30.0%	$ 90,000	$ 390,000	0.1%		
42	Site Restoration	75	Acres	$ 5,000	$ 375,000	30.0%	$ 112,500	$ 487,500	0.1%		
J	Instrumentation & SCADA				$ 1,500,000	30%	$ 450,000	$ 1,950,000		$ 1,950,000	0.5%
43	Instrumentation & ADAS	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.2%		
44	SCADA	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.2%		
Total Estimated Construction Cost (2017 dollars)					$ 334,041,730		$ 88,114,995	$ 422,156,725	100.0%	$ 422,156,725	100.0%
Overall Design Contingency						26.4%		$ 422,156,725			
Note: See Tech Memo for cost exclusions.									Q2 2017	Q4 2019*	Cost per AF
							Opinion of Probable Construction Cost		$ 422,200,000	$ 456,000,000	$ 6,000
							Estimated Range - Low (-20%)		$ 337,760,000	$ 364,800,000	$ 4,800
							Estimated Range - High (+20%)		$ 506,640,000	$ 547,200,000	$ 7,200
							Storage Increase (AF)				76,000
							* 8% escalation				

NID ROLLINS RESERVOIR - EMBANKMENT DAM RAISE

Opinion of Probable Construction Cost (AACE Class 4)

Base Year: 2017

Axis: Existing

Category/Item (WBS) No.	Description	Est. Pay Quantity	Units	Unit Price	Extension	% Contingency	Contingency Amount	Extension + Contingency	Line Item % of Total	Category Total	Category % of Total
A	Mobilization & Demobilization				$ 13,676,820	0%	$ -	$ 13,676,820		$ 13,676,820	7.0%
1	Mobilization & demobilization	1	LS	$ 13,676,820	$ 13,676,820	0.0%	$ -	$ 13,676,820	7.0%		
B	Site Development				$ 20,643,000	34.9%	$ 7,200,050	$ 27,843,050		$ 27,843,050	14.3%
2	Site preparation	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
3	Borrow area stripping	968,000	cy	$ 10.50	$ 10,164,000	35.0%	$ 3,557,400	$ 13,721,400	7.0%		
4	Quarry drill & blast	1,174,000	cy	$ 8.50	$ 9,979,000	35.0%	$ 3,492,650	$ 13,471,650	6.9%		
C	River Diversion				$ 2,000,000	30%	$ 600,000	$ 2,600,000		$ 2,600,000	1.3%
5	Diversion during construction	1	LS	$ 1,000,000	$ 1,000,000	30.0%	$ 300,000	$ 1,300,000	0.7%		
6	Cofferdams - upstream & downstream	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
7	Dewatering	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
D	Dam Foundation				$ 9,164,200	29%	$ 2,681,670	$ 11,845,870		$ 11,845,870	6.1%
8.1	Excavate existing dam crest	333,000	cy	$ 15.00	$ 4,995,000	30.0%	$ 1,498,500	$ 6,493,500	3.3%		
8.2	Foundation excavation	30,000	cy	$ 20.00	$ 600,000	30.0%	$ 180,000	$ 780,000	0.4%		
9	Initial cleaning - ogee & left abutment core foundation	6,000	sy	$ 20.00	$ 120,000	10.0%	$ 12,000	$ 132,000	0.1%		
10	Final cleaning - ogee & left abutment core foundation	6,000	sy	$ 20.00	$ 120,000	10.0%	$ 12,000	$ 132,000	0.1%		
11	Ogee & core surface prep (includes dental concrete)	6,000	sy	$ 25.00	$ 150,000	25.0%	$ 37,500	$ 187,500	0.1%		
12	Shell foundation surface cleaning	40,300	sy	$ 14.00	$ 564,200	10.0%	$ 56,420	$ 620,620	0.3%		
13	Backfill concrete	1,200	cy	$ 500.00	$ 600,000	30.0%	$ 180,000	$ 780,000	0.4%		
14	Abutment grout curtains	13,000	lf	$ 155.00	$ 2,015,000	35.0%	$ 705,250	$ 2,720,250	1.4%		
E	Embankment Dam Raise				$ 28,396,000	35%	$ 9,938,600	$ 38,334,600		$ 38,334,600	19.6%
15	Core zone (excavate, load, haul, place, compact)	125,000	cy	$ 16.00	$ 2,000,000	35.0%	$ 700,000	$ 2,700,000	1.4%		
16	Rockfill zones (haul, place, compact)	1,400,000	cy	$ 12.00	$ 16,800,000	35.0%	$ 5,880,000	$ 22,680,000	11.6%		
17.1	Filter/drain zones (purchase & deliver)	194,000	ton	$ 32.00	$ 6,208,000	35.0%	$ 2,172,800	$ 8,380,800	4.3%		
17.2	Filter/drain zones (haul from stockpile, place, compact)	121,000	cy	$ 28.00	$ 3,388,000	35.0%	$ 1,185,800	$ 4,573,800	2.3%		
F	Spillway				$ 63,915,000	32%	$ 20,546,250	$ 84,461,250		$ 84,461,250	43.3%
18	Demo existing slab & spillway walls (reinforced concrete)	7,500	cy	$ 450.00	$ 3,375,000	25.0%	$ 843,750	$ 4,218,750	2.2%		
19	Common excavation	62,500	cy	$ 15.00	$ 937,500	30.0%	$ 281,250	$ 1,218,750	0.6%		
20	Rock excavation	62,500	cy	$ 25.00	$ 1,562,500	30.0%	$ 468,750	$ 2,031,250	1.0%		
21	Foundation cleaning	16,000	sy	$ 20.00	$ 320,000	25.0%	$ 80,000	$ 400,000	0.2%		
22	Chute spillway concrete walls (reinforced concrete)	1,000	cy	$ 1,230.00	$ 1,230,000	30.0%	$ 369,000	$ 1,599,000	0.8%		
23	Chute spillway invert slab (reinforced concrete)	11,000	cy	$ 740.00	$ 8,140,000	30.0%	$ 2,442,000	$ 10,582,000	5.4%		
24	Ogee crest raise (mass concrete)	25,000	cy	$ 860.00	$ 21,500,000	35.0%	$ 7,525,000	$ 29,025,000	14.9%		
25	Left abutment gravity wall (mass concrete)	24,000	cy	$ 760.00	$ 18,240,000	35.0%	$ 6,384,000	$ 24,624,000	12.6%		
26	Anchors (fully grouted, 20' long, #9 bars)	42,000	lf	$ 205.00	$ 8,610,000	25.0%	$ 2,152,500	$ 10,762,500	5.5%		
G	Spillway Bridge				$ 2,700,000	30%	$ 810,000	$ 3,510,000		$ 3,510,000	1.8%
27	Deck & pier	6,000	sf	$ 450.00	$ 2,700,000	30.0%	$ 810,000	$ 3,510,000	1.8%		

H	Outlet & Intake Structures & Pipe				$ 6,412,000	30%	$ 1,919,900	$ 8,331,900		$ 8,331,900	4.3%
28	Power/outlet structure	1	LS	$ 1,000,000	$ 1,000,000	35.0%	$ 350,000	$ 1,350,000	0.7%		
29	Steel outlet pipe (8' dia.)	300	lf	$ 3,040.00	$ 912,000	20.0%	$ 182,400	$ 1,094,400	0.6%		
30	Intake/trashrack	1	LS	$ 750,000	$ 750,000	35.0%	$ 262,500	$ 1,012,500	0.5%		
31	Mechanical (gates, valves, actuators, ventilation)	1	LS	$ 3,000,000	$ 3,000,000	30.0%	$ 900,000	$ 3,900,000	2.0%		
32	Electrical controls and lighting	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.5%		
I	Misc. Civil				$ 2,038,000	30%	$ 611,400	$ 2,649,400		$ 2,649,400	1.4%
33	Backfill	20,000	cy	$ 10.40	$ 208,000	30.0%	$ 62,400	$ 270,400	0.1%		
34	Roadways (paved)	1	LS	$ 250,000	$ 250,000	30.0%	$ 75,000	$ 325,000	0.2%		
35	Heavy riprap (on-site borrow)	3,000	cy	$ 60.00	$ 180,000	30.0%	$ 54,000	$ 234,000	0.1%		
36	Site Restoration	130	Acres	$ 5,000	$ 650,000	30.0%	$ 195,000	$ 845,000	0.4%		
37	Forebay & canal headworks	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.5%		
J	Instrumentation & SCADA				$ 1,500,000	30%	$ 450,000	$ 1,950,000		$ 1,950,000	1.0%
38	Instrumentation & ADAS	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.5%		
39	SCADA	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.5%		
Total Estimated Construction Cost (2017 dollars)					$ 150,445,020		$ 44,757,870	$ 195,202,890	100.0%	$ 195,202,890	100.0%
Overall Design Contingency						29.8%		$ 195,202,890			
Note: See Tech Memo for cost exclusions.									Q2 2017	Q4 2019*	Cost per AF
							Opinion of Probable Construction Cost		$ 195,200,000	$ 210,800,000	$ 4,216
							Estimated Range - Low (-20%)		$ 156,160,000	$ 168,700,000	$ 3,374
							Estimated Range - High (+20%)		$ 234,240,000	$ 253,000,000	$ 5,060
							Storage Increase (AF)				50,000
							* 8% escalation				

Appendix B
Opinion of Probable Construction Cost for Centennial Dam

NID CENTENNIAL RESERVOIR - RCC DAM CONCEPT

Opinion of Probable Construction Cost (AACE Class 3-4), 5/12/17

Base Year: 2017

Axis: Centennial Site 2

Category/Item (WBS) No.	Description	Est. Pay Quantity	Units	Unit Price	Extension	% Contingency	Contingency Amount	Extension + Contingency	Line Item % of Total	Category Total	Category % of Total
A	Mobilization & Demobilization				$ 18,736,890	0%	$ -	$ 18,736,890		$ 18,736,890	7.3%
1	Mobilization & demobilization	1	LS	$ 18,736,890	$ 18,736,890	0.0%	$ -	$ 18,736,890	7.3%		
B	Site Development				$ 15,942,500	34.8%	$ 5,554,875	$ 21,497,375		$ 21,497,375	8.4%
2	Site preparation	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
3	Borrow area stripping	900,000	cy	$ 10.50	$ 9,450,000	35.0%	$ 3,307,500	$ 12,757,500	5.0%		
4	Quarry drill & blast	705,000	cy	$ 8.50	$ 5,992,500	35.0%	$ 2,097,375	$ 8,089,875	3.2%		
C	River Diversion				$ 2,000,000	30%	$ 600,000	$ 2,600,000		$ 2,600,000	1.0%
5	Diversion during construction	1	LS	$ 1,000,000	$ 1,000,000	30.0%	$ 300,000	$ 1,300,000	0.5%		
6	Cofferdams - upstream & downstream	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
7	Dewatering	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
D	Dam Foundation				$ 32,743,000	28%	$ 9,118,850	$ 41,861,850		$ 41,861,850	16.3%
8.1	Foundation excavation - common	450,000	cy	$ 11.00	$ 4,950,000	30.0%	$ 1,485,000	$ 6,435,000	2.5%		
8.2	Foundation excavation - rock	150,000	cy	$ 21.50	$ 3,225,000	30.0%	$ 967,500	$ 4,192,500	1.6%		
9	Initial cleaning	30,000	sy	$ 20.00	$ 600,000	10.0%	$ 60,000	$ 660,000	0.3%		
10	Final cleaning	30,000	sy	$ 20.00	$ 600,000	10.0%	$ 60,000	$ 660,000	0.3%		
11	Surface preparation	30,000	sy	$ 25.00	$ 750,000	25.0%	$ 187,500	$ 937,500	0.4%		
12	Levelling concrete	18,000	cy	$ 280.00	$ 5,040,000	30.0%	$ 1,512,000	$ 6,552,000	2.6%		
13	Grout curtains	41,000	lf	$ 155.00	$ 6,355,000	35.0%	$ 2,224,250	$ 8,579,250	3.4%		
14	Structural concrete - grouting plinth	4,500	cy	$ 1,230.00	$ 5,535,000	20.0%	$ 1,107,000	$ 6,642,000	2.6%		
15	Grouting plinth anchors	6,400	lf	$ 205.00	$ 1,312,000	20.0%	$ 262,400	$ 1,574,400	0.6%		
16	Consolidation grouting	24,000	lf	$ 105.00	$ 2,520,000	35.0%	$ 882,000	$ 3,402,000	1.3%		
17	Drain holes	16,000	lf	$ 116.00	$ 1,856,000	20.0%	$ 371,200	$ 2,227,200	0.9%		
E	RCC, Facing Concrete & Gallery				$ 109,060,000	25%	$ 27,265,000	$ 136,325,000		$ 136,325,000	53.2%
18	RCC, facing concrete & gallery	811,000	cy	$ 108.00	$ 87,588,000	25.0%	$ 21,897,000	$ 109,485,000	42.8%		
19	Cement for RCC - Type II	61,000	ton	$ 210.00	$ 12,810,000	25.0%	$ 3,202,500	$ 16,012,500	6.3%		
20	Class F fly ash for RCC	61,000	ton	$ 142.00	$ 8,662,000	25.0%	$ 2,165,500	$ 10,827,500	4.2%		
F	Spillway & Dam Crest				$ 10,464,400	22%	$ 2,301,225	$ 12,765,625		$ 12,765,625	5.0%
21	Spillway & stilling basin walls	3,650	cy	$ 1,230.00	$ 4,489,500	25.0%	$ 1,122,375	$ 5,611,875	2.2%		
22	Stilling basin slab	3,260	cy	$ 740.00	$ 2,412,400	25.0%	$ 603,100	$ 3,015,500	1.2%		
23	Crest slab	1,500	cy	$ 740.00	$ 1,110,000	15.0%	$ 166,500	$ 1,276,500	0.5%		
24	Parapet walls	650	cy	$ 1,250.00	$ 812,500	10.0%	$ 81,250	$ 893,750	0.3%		
25	Stilling basin anchors	8,000	lf	$ 205.00	$ 1,640,000	20.0%	$ 328,000	$ 1,968,000	0.8%		
G	Spillway Bridge				$ 1,800,000	30%	$ 540,000	$ 2,340,000		$ 2,340,000	0.9%
26	Deck & pier	4,000	sf	$ 450.00	$ 1,800,000	30%	$ 540,000	$ 2,340,000	0.9%		
H	Outlet & Intake Structures & Pipe				$ 11,379,000	30%	$ 3,379,600	$ 14,758,600		$ 14,758,600	5.8%
27	Outlet structure	1	LS	$ 2,500,000	$ 2,500,000	35.0%	$ 875,000	$ 3,375,000	1.3%		

28	Outlet chute walls	1,300	cy	$ 1,230.00	$ 1,599,000	30.0%	$ 479,700	$ 2,078,700	0.8%		
29	Outlet chute slab	1,100	cy	$ 740.00	$ 814,000	30.0%	$ 244,200	$ 1,058,200	0.4%		
30	Outlet chute anchors	4,400	lf	$ 205.00	$ 902,000	20.0%	$ 180,400	$ 1,082,400	0.4%		
31	Steel outlet pipe	350	lf	$ 3,040.00	$ 1,064,000	20.0%	$ 212,800	$ 1,276,800	0.5%		
32	Intake/trashrack	1	LS	$ 750,000	$ 750,000	35.0%	$ 262,500	$ 1,012,500	0.4%		
33	Mechanical (gates, valves, actuators, ventilation)	1	LS	$ 3,000,000	$ 3,000,000	30.0%	$ 900,000	$ 3,900,000	1.5%		
34	Electrical controls and lighting	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.4%		
I	Misc. Civil				$ 2,480,000	30%	$ 744,000	$ 3,224,000		$ 3,224,000	1.3%
35	Backfill	125,000	cy	$ 10.40	$ 1,300,000	30.0%	$ 390,000	$ 1,690,000	0.7%		
36	Roadways	1	LS	$ 250,000	$ 250,000	30.0%	$ 75,000	$ 325,000	0.1%		
37	Gallery portals	1	LS	$ 250,000	$ 250,000	30.0%	$ 75,000	$ 325,000	0.1%		
38	Heavy riprap	3,000	cy	$ 60.00	$ 180,000	30.0%	$ 54,000	$ 234,000	0.1%		
39	Site Restoration	1	LS	$ 500,000	$ 500,000	30.0%	$ 150,000	$ 650,000	0.3%		
J	Instrumentation & SCADA				$ 1,500,000	30%	$ 450,000	$ 1,950,000		$ 1,950,000	0.8%
40	Instrumentation & ADAS	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.4%		
41	SCADA	1	LS	$ 750,000	$ 750,000	30.0%	$ 225,000	$ 975,000	0.4%		
Total Estimated Construction Cost (2017 dollars)					$ 206,105,790		$ 49,953,550	$ 256,059,340	100.0%	$ 256,059,340	100.0%
Overall Design Contingency						24.2%		$ 256,059,340			
Note: See Tech Memo for cost exclusions.									Q2 2017	Q4 2019*	Cost per AF
							Opinion of Probable Construction Cost		$ 256,100,000	$ 276,600,000	$ 2,515
							Estimated Range - Low (-15%)		$ 217,685,000	$ 235,100,000	$ 2,137
							Estimated Range - High (+20%)		$ 307,320,000	$ 331,900,000	$ 3,017
							Storage Increase (AF)				110,000
							* 8% escalation				

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