



DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

STAKEHOLDER ENGAGEMENT COMMITTEE (SEC)

Soils & RTM Management

Graham Bradner, Levees/Forebay Lead

Agenda

1. Use of RTM

2. Soils Material Balance

1. Use of RTM

Disclaimer: These pages are for Stakeholder Engagement Committee discussion purposes only. They do not represent a decision by the DCA or DWR. Final decisions about the project will be made by DWR and will NOT be made until the concluding stages of the CEQA process.

JUNE 24, 2020

Reusable Tunnel Material (RTM) Overview

- ~6 to 15 Mil CYs of RTM will be generated during tunnel boring operations
- Will need ~20 MCYs of soil fill at project sites for various project features
- Effects of hauling and logistical constrictions highlight need to optimize material uses



RTM Generation Sites

Central Alignment

- Twin Cities
- Bouldin Island
- Southern Complex

Eastern Alignment

- Twin Cities
- Lower Roberts
- Southern Complex



Disclaimer: These pages are for Stakeholder Engagement Committee discussion purposes only. They do not represent a decision by the DCA or DWR. Final decisions about the project will be made by DWR and will NOT be made until the concluding stages of the CEQA process.

Reusable Tunnel Material (RTM) Overview

- Tunnel depth expected at ~130 -160 ft below ground
- Older soils consisting of sands, silts, and clays w/ occasional buried stream channels
- Peats not anticipated



Previous Testing of RTM

- Soil samples collected from 19 borings along expected tunnel alignment and depth
- Blended w/ 3 typical soil conditioners and tested for material properties, strength, permeability, and toxicity
- Conditioner application purposefully higher than industry typical values









Overwater Bori

Historical Geotechnical Laboratory Testing

- Soil Classification
 - Moisture content (ASTM D2216),
 - Atterberg limits (ASTM D4318),
 - Gradation and hydrometer (ASTM D422)
- Constructability
 - Optimum moisture content and maximum dry density (ASTM D698)
- Geotechnical Performance
 - Remolded unconsolidated undrained triaxial shear strength (ASTM D2850)
 - Remolded consolidated undrained triaxial shear strength with pore pressure measurements (ASTM D4767)
 - Remolded consolidation (ASTM D2435) and permeability (ASTM D5084)



Embankment Design Criteria

Characteristic	USACE Geotechnical Levee Practice ¹	CCR Title 23 ²	Samples w/o Conditioners	Samples w/ Conditions (RTM)
Maximum particle size	2 inches	2 inches	<1% gravel	<1% gravel
% Fines (pass No. 200 sieve)	Fines ≥ 20%	Fines ≥ 30%	Fines = 67% to 69%	Fines = 45% to 71% 🗹
Plasticity Index (PI)	8 ≤ PI < 40	8 ≤ PI ≤ 40	PI = 19 to 20	PI = 9 to 23
Liquid Limit (LL)	LL ≤ 45	LL ≤ 45	LL = 38	LL = 40 to 46
Other Criteria	Free of objectionable matter	g _{sat} ≥ 112 pcf Organics ≤ 2% by vol; No unsatisfactory materials ³		

1) Geotechnical Levee Practice, USACE, Sacramento District, Engineering Division, GEEB, 04/11/2008.

- 2) CCR, Title 23-Proposed Technical Changes, Division 1. Central Valley Flood Protection Board, Article 8. Standards, Section 120. Levees. Updated May 21, 2011 (legal review pending).
- 3) Unsatisfactory materials are described in the Title 23-Proposed Technical Changes as materials "such as trash, etc."

Additional testing

Could be related to dispersive qualities of conditioners that breakdown clays and silts. Will be studied further.



Strength and compressibility

- Minor increase in compressibility and slight decrease in shear strength for conditioned soils, but not considered significant

Permeability

- Hydraulic conductivity reduced for conditioned soils
- Health, Environment, and Ecology (data reviewed by environmental specialists)
 - Hydrocarbons and pesticides not detected
 - Metals and inorganics generally resemble naturally occurring levels
 - Cadmium detected above typical background, but below environmental screening levels for health or ecological impacts
- RTM Management approach includes holding period for environmental testing

Soil Moisture Content

- Soil strength varies with water content
- Optimum water content for soil strength varies by soil type but typically ranges from ~17 to 23%
- The RTM from tunnel operations may be ~30 to 45% water content
- To use the RTM for structural fill, moisture must be removed

Typical Moisture Density Curve showing relationship between soil strength and percent water content.



Methods Considered to Dry RTM

Natural Drying

- Spread in ~18-inch lifts
- Daily tilling & discing to mix soil
- About 2-3 weeks drying time per lift
- Hot, dry weather needed (req. significant wet storage containment)
- Land intense

Mechanical Drying - Heated Drying

- Uses thermal dryers to remove moisture directly from conveyors
- Requires more power at a greater capital cost, up to 9 dryers per tunnel
- Allows year-round drying •
- Significantly less heavy equipment required
- Compatible with secondary natural drying method



Small

Summary





Project Team sees opportunity with RTM

- Tremendous need for soil fill and will produce excess quantities of RTM
- Project circumstances drive creative thinking about using available resources
- Pre- and Post-conditioned samples meet State and Federal embankment requirements
- Additional testing for strength and permeability show RTM to be viable as embankment fill

Further Study

- Potential dispersive effects of the conditioners; zoned embankments resolve issue for now
- Continue to analyze and evaluate geotechnical and environmental properties
- Biggest issue: moisture content; comes out wet, but have included processes for drying the material before use

2. Soils Materials Balance

Disclaimer: These pages are for Stakeholder Engagement Committee discussion purposes only. They do not represent a decision by the DCA or DWR. Final decisions about the project will be made by DWR and will NOT be made until the concluding stages of the CEQA process.

JUNE 24, 2020

EASTERN ALIGNMENT OVERVIEW

	FILL MATERIAL (CY)	
SITE	NEEDED	IMPORTED
Intake 3	1,863,000	55,000
Intake 5	1,684,000	55,000
Twin Cities Complex	501,000	82,000
New Hope Tract Maintenance Shaft	69,000	58,000
Canal Ranch Tract Maintenance Shaft	107,000	96,000
Terminous Tract Reception Shaft	236,000	213,000
King Island Maintenance Shaft	147,000	136,000
Lower Roberts Tract Launch/Reception Shaft	449,000	0
Upper Jones Tract Maintenance Shaft	182,000	170,000
Southern Complex Launch Shaft	404,000	393,000
Southern Forebay	8,502,000	3,515,000
South Delta Conveyance	616,000	0



Sample Logistics Page

EASTERN ALIGNMENT

Twin Cities Complex

Site Name and an aerial view of each site with a simplified construction footprint



Summary Table

Description	Volume (CCY)	Source/Haul	Cabada
NEEDED (shaft pad)	200,000		Scheat
NEEDED (levee)	300,000		
NEEDED (export)	1,353,000		
			ing, 1
ON-SITE	501,000	TCC Excavation	
ON-SITE	1,137,000	TCC RTM	
ON-SITE	134,000	Twin Cities Shaft Excavation	1
EXCESS	0	N/A	

Truck Hauling Schedule



Summary Table of logistics details – within the table, imported sources are identified by color in the Truck Hauling Schedule

Intake 3



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	1,863,000	
IMPORT	55,000	Quarry/Off Site Borrow
ON-SITE	1,808,000	Intake Excavation
EXCESS	0	N/A

Truck Hauling Schedule



Years

Intake 5



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	1,684,000	
IMPORT	55,000	Quarry/Off Site Borrow
ON-SITE	1,629,000	Intake Excavation
EXCESS	0	N/A

Truck Hauling Schedule



Twin Cities Complex



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED (shaft pad)	200,000	
NEEDED (levee)	300,000	
NEEDED (export)	1,353,000	
IMPORT	82,000	New Hope, Canal Ranch, King,
		Terminous Shart Excavation
ON-SITE	501,000	TCC Excavation
ON-SITE ON-SITE	501,000 1,137,000	TCC Excavation TCC RTM
ON-SITE ON-SITE ON-SITE	501,000 1,137,000 134,000	TCC Excavation TCC RTM Twin Cities Shaft Excavation

Truck Hauling Schedule



New Hope Maintenance Shaft



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	69,000	
IMPORT	58,000	TCC Excavation
ON-SITE	11,000	New Hope Shaft Excavation
EXCESS	25,000	То ТСС

Truck Hauling Schedule



Years

Canal Ranch Maintenance Shaft



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	107,000	
IMPORT	96,000	TCC Excavation
ON-SITE	11,000	Canal Ranch Shaft Excavation
EXCESS	24,000	то ТСС

Truck Hauling Schedule



Years

Terminous Reception Shaft



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	236,000	
IMPORT	213,000	TCC Excavation
ON-SITE	23,000	Terminous Shaft Excavation
EXCESS	10,000	То ТСС

Truck Hauling Schedule



Years

King Maintenance Shaft



Summary TableDescriptionVolume (CCY)Source/HaulNEEDED147,000ImportIMPORT136,000TCC ExcavationON-SITE11,000King Shaft ExcavationEXCESS25,000To TCC

Truck Hauling Schedule



Years

Lower Roberts Launch Shaft



Summary Table

Description	Volume (CCY)	Need/Source
NEEDED (shaft pad)	393,000	
NEEDED (levee)	56,000	
NEEDED (export)	1,015,000	
ON-SITE	449,000	Lower Roberts Excavation
ON-SITE	952,000	Lower Roberts RTM
ON-SITE	63,000	Lower Roberts Shaft Excavation
EXCESS	0	N/A

Truck Hauling Schedule

No Hauling Needed

Upper Jones Maintenance Shaft



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	182,000	
IMPORT	170,000	Lower Roberts Excavation
ON-SITE	12,000	Upper Jones Shaft Excavation
EXCESS	23,000	To Southern Forebay

Truck Hauling Schedule



Southern Complex Launch Shafts



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	404,000	
ON-SITE	11,000	Southern Complex Launch Shaft Excavation
ON-SITE	393,000	Southern Forebay Excavation
EXCESS	26,000	To Southern Forebay

Truck Hauling Schedule

No Hauling Needed

Southern Forebay



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	8,502,000	
IMPORT	562,000	Quarry/Off Site Borrow
IMPORT	23,000	Surplus from Upper Jones Shaft
IMPORT - RAIL	980,000	TCC RTM
ON-SITE	2,327,000	Southern Forebay Excavation
ON-SITE	1,924,000	South Delta Conveyance Early Excavation
ON-SITE	26,000	Surplus from Southern Complex Working Shaft
ON-SITE	2,660,000	Southern Forebay RTM
EXCESS	393,000	Early Excavation to Southern Complex Working Shaft

Truck Hauling Schedule



South Delta Conveyance



Summary Table

Description	Volume (CCY)	Need/Source
NEEDED	616,000	
ON-SITE	616,000	South Delta Connection-Excavation
EXCESS	1,924,000	Early Excavation to Southern Forebay
EXCESS	180,000	Spread on Site

Truck Hauling Schedule

No Hauling Needed



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	496,000	
IMPORT	496,000	Quarry/Off Site Borrow (to 14 Sites)
EXCESS	0	N/A

Truck Hauling Schedule



Years

CENTRAL ALIGNMENT OVERVIEW

		FILL MATE	ERIAL (CY)
	SITE	NEEDED	IMPORTED
Shared	Intake 3	1,862,763	55,000
Shared	Intake 5	1,684,425	55,000
Shared	Twin Cities Complex	200,400	81,685
	New Hope Maintenance Shaft	66,470	54,230
	Staten Maintenance Shaft	155,960	144,800
	Bouldin Launch/Reception Shaft	730,156	669,383
	Mandeville Maintenance Shaft	210,280	199,550
	Bacon Reception Shaft	403,520	373,475
Shared	Southern Complex Launch Shaft	404,010	393,080
	Southern Forebay	8,501,653	3,720,116
Shared	South Delta Conveyance	615,539	Х



New Hope Maintenance Shaft



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	66,000	
IMPORT	54,000	TCC Excavation
ON-SITE	12,000	New Hope Shaft Excavation
EXCESS	23,000	то ТСС

Truck Hauling Schedule



Staten Maintenance Shaft



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	156,000	
IMPORT	145,000	TCC Excavation
ON-SITE	11,000	Staten Island Shaft Excavation
EXCESS	22,000	То ТСС

Truck Hauling Schedule



Years

Bouldin Launch Shaft



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED (shaft pad)	505,000	
NEEDED (levee)	225,000	
INADODT		
ΙΜΡΟΚΙ	669,000	TCC Excavation
ON-SITE	669,000	TCC Excavation Bouldin Shaft Excavation

Truck Hauling Schedule



Years

Mandeville Maintenance Shaft



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	210,000	
IMPORT	200,000	TCC RTM
ON-SITE	11,000	Mandeville Shaft Excavation
EXCESS	23,000	To Southern Forebay

Truck Hauling Schedule



Years

Bacon Reception Shaft



Summary Table		
Description	Volume (CCY)	Source/Haul
NEEDED	404,000	
IMPORT	373,000	TCC RTM
ON-SITE	30,000	Bacon Island Shaft Excavation
EXCESS	0	N/A

Truck Hauling Schedule



Years

Southern Forebay



Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	8,502,000	
IMPORT	562,000	Quarry/Off Site Borrow
IMPORT	23,000	Surplus from Mandeville Shaft
IMPORT-RAIL	1,185,000	TCC RTM
ON-SITE	2,327,000	Southern Forebay Excavation
ON-SITE	1,924,000	South Delta Connection Early Excavation
ON-SITE	26,000	Surplus from Southern Complex Working Shaft
ON-SITE	2,455,000	Southern Forebay RTM
EXCESS	393,000	Excavation to Southern Complex Working Shaft

Truck Hauling Schedule

CENTRAL ALIGNMENT

Summary Table

Description	Volume (CCY)	Source/Haul
NEEDED	842,000	
IMPORT	842,000	Quarry/Off Site Borrow (to 15 Sites)
EXCESS	0	N/A

Truck Hauling Schedule

Disclaimer: These pages are for Stakeholder Engagement Committee discussion purposes only. They do not represent a decision by the DCA or DWR. Final decisions about the project will be made by DWR and will NOT be made until the concluding stages of the CEQA process.