SAN BERNARDINO COUNTY
SOLID WASTE MANAGEMENT DIVISION
222 West Hospitality Lane, 2nd Floor
San Bernardino, CA 92415-0017
Fax: 909-386-8900

ADDENDUM NO. 5

FINAL CLOSURE CONSTRUCTION IMPROVEMENTS AT THE COLTON SANITARY LANDFILL

JUNE 22, 2022

~~BIDS OPEN: 10:00A.M. JUNE 2, 2022~~
~~BIDS OPEN: 10:00A.M. JUNE 22, 2022~~
BIDS OPEN: 10:00A.M. JULY 7, 2022

GENERAL:

I. **A source for import material is available at the Mid-Valley Landfill. "SWMD has identified an Approved Source for Import Material (described in the Project Technical Specifications Section 2D 2.1.2) located at the San Bernardino County owned Mid-Valley Sanitary Landfill (2390 Alder Ave, Rialto, CA 92377). The Import source is approximately 12-16 miles away from the Colton Sanitary Landfill. The attached Figure 1 shows the approximate location of the material stockpile at the Mid-Valley Landfill.**

There will be no cost associated with purchasing the dirt from San Bernardino County. Import/export operations at the Mid-Valley Landfill must occur during regular business hours Monday-Friday 7:00AM-5:00PM". Contractor will be responsible for loading, hauling, and screening to remove cobbles/rocks that are 4" and larger.

AMEND THE SPECIAL PROVISIONS AS FOLLOWS:

II. **Delete and replace in its entirety Bid Schedule supplied in ADDENDUM 3 with the attached Bid Schedule Pages 23 thru 29 - ADDENDUM 5 (attached).** Bids must be submitted on these sheets or will be deemed Non-responsive.

QUESTIONS:

III. **The following question(s) have been received by bidders:**

Q1. We would like to suggest that the bid date be extended by a period of at least two weeks to confidently secure complete and responsive information and pricing from vendors and subcontractors.

A1. Please see Addendum 4.

Q2. Please confirm the geosynthetic materials will be considered exempt from the calculation of the primer performing a minimum of 50% of the value of the work? As a prime we would like to avoid procuring large dollar materials that are to be installed by specialty subs for the sole purpose of attempting to show we are performing 50% of the value of the work. We anticipate the procurement of these materials will be better handled by the subcontractor responsible for the installation (including: coordination with the manufacturer, calculating waste factors, special roll lengths, conformance sampling / testing, sequence of delivery, unloading and storage).

A2. Please see Addendum 2.

Q3. Please confirm that the County will pay for stored liner materials at the approved SOV unit rate and not at "raw invoice cost". Raw invoice cost would cause a considerable cash flow strain as it may not account for freight, taxes, conformance sampling / testing, submittals, unloading, etc….

A3. The County will only pay for raw invoice cost, including taxes and delivery.

Q4. Long Haul Freight Cost Concern – It is anticipated that the closure liner system components will result in ~100 truckloads of material being shipped via long haul flatbed trucks. Will the County consider using an industry index with an established baseline (DAT Freight & Analytics www.dat.com) as the basis for an adjustment comparing the difference between freight rates at the time of the bid to rates at time of shipment?

A4. Please see Addendum 2.

Q5. Volatile Cost of PE Raw Materials Concern – It is anticipated that the PE resin required to produce the LLDPE liner will exceed 1.2 million pounds. PE resin cost remains volatile. Will the County consider using and industry index with an established baseline (IHS Global Plastics & Polymers) as the basis for an adjustment comparing the difference between resin costs at the time of the bid to costs at time of production?

A5. Please see Addendum 2.

Q6. Please identify the hydrant that contractors will utilize for construction water for the project. If the hydrant is outside of the main access gate, can contractors build a temporary high line to bring the water closer to the work area? Will the contractors be responsible for the purchase of all construction water?

A6. Contractor is responsible for securing a source for construction water and costs. Contractor may construct temporary lines within County property. Contractor will need to seek approval from governing agency (City and Water Company) for any facilities constructed within public right of way.

Q7. Please identify the location for the CM & CQA Field Offices that the contractor is to provide for the project. Are there existing power and water services available to tie into?

A7. The CM & CQA Field Office should be located in the vicinity of where everyone parked during the job walk. Power poles are located nearby. Water service is approximately 500 feet away.

Q8. Can existing dead vegetative material on slopes be tracked in and rolled prior to geosynthetics installation or does all vegetation need to be completely removed?

A8. Yes, dead vegetation can be track walked and rolled prior to installation of geosynthetics in areas not receiving fill as long as it meets the requirements of Technical Specification Section 2D item 3.3.

In areas receiving fill, all vegetation needs to be completely removed. Clearing and grubbing within the Slope/Bench Subgrade Fill Areas, and the Final Cover Soil removal area shall be performed in accordance with Section 300-1 of the SSPWC.

Q9. How long can a 4 acre phase be decommissioned and shut down?

A9. Please refer to paragraph 3, Section 2C Clearing and Grubbing Demolition / Salvage, subsection 1.0 General.

Q10. To minimize the product waste is it acceptable to use horizontal seams along slopes?

A10. Horizontal seams are acceptable along the slopes as long as they are staggered or spaced out from adjacent horizontal seam slope panel and compliant with the manufacturer's recommendation.

Q11. Due to the complexity of the job, we ask that there is an extension.

A11. Please see Addendum 4.

Q12. Can the payment basis for the platypus anchors be adjusted to EA instead of LS (Bid Item 10G)? This does not accurately reflect the standard of how anchors are determined.

A12. Bid Item 10G Units changed to "EA" or Each and the Estimated Quantity is provided in the bid schedule attached with this addendum.

Q13. What 3rd party CQA are you using for the Lite Earth system – this is essential for us so we can know what we need to expect on our installation.

A13. Advanced Earth Sciences, Inc. 9307 Research Drive, Irvine, CA 92618

Q14. Please clarify that the contractor is to only bid 1 option on the geosynthetics either the Closure Turf System or the LightEarth System.

A14. Yes, bid only one option.

Q15. Is conformance testing required – who is in charge of this?

A15. Yes, conformance testing for the selected alternative is required. Conformance sampling, testing and reporting are described in their respective Specification Sections 2G-A/2G-B. All associated costs will be paid by the contractor.

Q16. Due to the high volume of materials to be stored onsite is another storage area available or can an additional storage area be created?

A16. The County will work with the Contractor to find storage area options onsite. If the question is suggesting to store offsite, the Contractor will be responsible for all costs associated with storing offsite to include but not limited to locating, securing, transporting, etc.

Q17. What turf color is required for this project?

A17. Blended mix of Green and Tan.

Q18. In the areas of channelized flow (i.e., downdrains), the design requires the use of HydroBinder infill for the ClosureTurf. What is the design for the armoring of the Lite Earth product in these channelized flow areas? If there is no armoring the Lite Earth in channelized flow areas, then who is responsible for maintaining these channelized flow areas during construction and after a storm event? For example, who is responsible for removing sediment? If the contractor is responsible, then please provide the procedures removing that sediment so that the Lite-Earth is not damaged?

A18. The LiteEarth product does not require armoring in concentrated flow areas. The Contractor is responsible for maintenance and upkeep of their work area(s) including the concentrated flow areas (e.g. downdrains). Construction items shall have a warranty by Installer against defects in workmanship for a period of 1 year from the date of project completion (County acceptance).

Q19. Has there been site specific pullout tests performed for the anchors of the Lite-Earth? If so, have these tests been performed at various depth increments? Without this information, the contractor cannot evaluate the feasibility and effort required for achieving the designed anchor load?

A19. No, site specific studies have not been performed. General performance studies have been performed by the manufacturer, and current Technical Data on Solmax LiteEarth product can be provided by the Manufacturer.

Q20. Is there a specification or known value for the pull-through strength of the anchor plate through the Lite-Earth geomembrane / turf layer? If this value is less than the maximum achievable anchor pull-out strength, the geomembrane / turf layer will rip at the plate prior to the anchor pulling out. Who is responsible for repairing this during construction and the warranty period?

A20. Yes, Solmax has performed pull tests on their Platipus Anchors at various loads, depths, and geosynthetic materials. Current Technical Data on Solmax LiteEarth product can be provided by the Manufacturer. The Contractor is responsible for repairs during construction activities and warranty period of 1 year from the date of project completion (County acceptance).

Q21. How long does the contractor have to warranty the glued bond between the turf and geomembrane for the lite-earth product? This would include parent material, caps, flaps, and patches.

A21. Installation of LiteEarth shall have a warranty by Installer against defects in workmanship for a period of 1 year from the date of project completion (County Acceptance).

Q22. For Lite-Earth, how is the QC and QA testing performed on extrusion welded seams? Vacuum box testing is not realistic since the turf will be in the way.

A22. The LiteEarth product has two types of pre-manufactured Weld Edges that allow for competent welding and QA/QC activities where the turf will not be in the way, summarized below:

Overlap Allowance Side: One side of the roll has 8 inches (20 cm) of blank turf backing geotextile and 8 inches (20 cm) of geomembrane. These materials are not laminated to one another – so that the membrane and the turf components can be welded to adjacent rolls separately.

Anchor Installation Side: On the other side of the roll, there is an anchoring section where the turf and membrane are not factory-laminated within 18 inches (46 cm) of the edge of the roll. This area contains room for Platipus Earth Anchors and wedge welds. The turf is field-laminated to the membrane in this section during installation.

Please refer to the Solmax LiteEarth current installation guide, also provided in the Technical Specifications as Attachment 2H-B1 to section 2H-B, for additional Technical Information.

Note that all dual-hot wedge seams will be testing using the air pressure test. Extrusion welds can be tested using the vacuum box or spark tests.

Q23. Pressure Relief Valves are proprietary to the ClosureTurf technology. Please provide the equivalent product or a design of a relief valve for the Lite-Earth system. (Ref Area: LFG Bid Item G17 – Pressure Relief Valve per Detail 6/GD14 and Section 2.1 – Passive Pressure Relief Valves)

A23. See attached LiteEarth Pressure Relief Valve Design. Alternative "B" pressure relief valves will be incidental to the Square Footage bid items for the geosynthetics – Bid Items No. 9A and 9B.

Q24. Ref Area : Section 3.3.2 – Prior to installation, the Contractor shall visually inspect all LiteEarth Material for imperfections, faulty or suspect areas and possible damage. All such defective geomembrane shall be marked, repaired, and/or tested. Question: Given that the turf component is already applied to the geomembrane prior to arrival to the site, please describe how the installer is to visually inspect for "defective geomembrane" as required?

A24. In areas of welding edges, repair patches, penetrations, etc. where the geomembrane will be exposed, the contractor can visually inspect the geomembrane. In all other areas, the contractor can visually inspect the LiteEarth integral system for possible damage (e.g. protrusions, holes, tears).
Please refer to the Solmax LiteEarth current installation guide, also provided in the Technical Specifications as Attachment 2H-B1 to section 2H-B, for additional Technical Information.

Q25. Ref Area: Section 3.4.6 Question: Please clarify what geomembrane material can be used for daily geomembrane trial seams, given that the turf component is already adhered to the geomembrane component.

A25. It is anticipated that scrap material or waste product can be used for trial seams. The Solmax LiteEarth product has pre-manufactured welding edges with exposed (not laminated) geomembrane.

Q26. Ref Area: Section 3.5.6 - Final Seam Inspection - For final seaming inspection, seams and surface of geomembrane shall be checked for defects, holes, blisters, undispersed raw materials, and signs of contamination by foreign matter. The geomembrane surface shall be brushed, blown, and/or washed if dirt inhibits inspection. The Engineer/CQA Monitor shall decide if cleaning of geomembrane surface and welds is needed to facilitate inspection. The Contractor shall distinctively mark, preferably with paint, repair areas and indicate required type of repair. Question: Please clarify how the Installer will perform inspections as required of the surface of the geomembrane if the turf is already applied to the geomembrane prior to delivery to the site?

A26. In areas of welding edges, repair patches, penetrations, etc where the geomembrane will be exposed, the contractor can visually inspect the geomembrane.

Please refer to the Solmax LiteEarth current installation guide, also provided in the Technical Specifications as Attachment 2H-B1 to section 2H-B, for additional Technical Information.

Q27. Ref Area: Section 4.0 Measurement & Payment Question: Given the large number of anchors / penetrations required for the LiteEarth option, please confirm if the supply / installation of anchors will be considered incidental to the installation of the product? If so, given the unknown materials within a landfill, how will payment be managed for additional anchors due to refusal of an anchor, encountering / avoiding the landfill gas system, and/or encountering a soft area in the landfill where achieving the required pullout is not possible?

A27. For each Platipus Anchor installed, the supply, placement, tensioning, labor, tools, equipment, materials, and all incidentals necessary to complete the work will be considered incidental to the Platipus Anchor Bid Item No.10G. Bid Item No. 10G, paid for by Each anchor installed will be utilized for an increase or decrease in the total amount of Platipus Anchors Installed. Contractors should assume 10% refusals or pull out fails, if greater than 10%, SWMD will compensate ½ unit price per exceeded refusal or pull out failure.

Geosynthetic items associated with successful installation of Platipus Anchors (patch material, welding, boots, etc) will be incidental to the Square Footage bid items for the geosynthetics – Bid Items No. 9A and 9B).

Q28. Ref Area: Section 4.0 Measurement & Payment Question: How will the landfill gas system be identified above the installed liteearth and what party is responsible to avoid damage to the landfill gas system from installed anchors?

A28. The General Contractor will be responsible for working together with subcontractor(s) to establish location of the new LFG system and to protect it in place while installing Platipus Anchors. The General Contractor will be responsible for damages to the new LFG system during project construction activities.

Q29. Ref Area: Section 4.0 Measurement & Payment Question: How will damage to the landfill gas system from an installed anchor be handled, paid for and which party will be responsible for the repair?

A29. The General Contractor will be responsible for damages to the LFG system (new and existing still connected) during project construction activities.

Q30. Ref Area: Section 4.0 Measurement & Payment Question: Will an addendum be coming showing the anchor locations and how they interact with the gas infrastructure, downdrains, benches, etc?

A30. No – Platipus Anchor Layout/Location is considered a means and method item determined by the General Contractor, geosynthetics installer, and manufacturer. Platipus Anchor layout, uniform spacing vs. variable spacing, shall meet the minimum requirements of the manufacturer's takeoff/calculation against wind uplift. A Platipus Anchor layout (or plan) similar to geosynthetic panel layout submittals is required for this Project. The manufacturer has provided additional information on this and is included as a part of this addendum.

Q31. Ref Area: Section 2H-B Alternative B Platipus Anchors/Geotextile/Bench Rock Ballast, 3.2 Anchor Installation and Detail Requirements, Item C.2 - this requires installation at 90 degree angle of inclination. At slopes steeper than 3:1, equipment may be needed to allow for operation of the hammer given the depth needed to obtain desired loading. Question: Please confirm if equipment will be allowed to operate on the Liteearth product on the top deck and slopes in order to allow for material deployment and anchor installation? If so, are there any requirements to the type of equipment?

A31. Please refer to Technical Specification Section 2H-B item 3.1 Installation – equipment on Engineered Turf – Alternative B Only, and confirm any proposed ATV type vehicle loads with the manufacturer.

Q32. How long must the installed anchors maintain the minimum loading requirement?

A32. The Contractor is responsible for repairs/maintenance during construction activities and warranty period of 1 year from the date of project completion (County acceptance).

Q33. If anchors need to be re-tensioned after completion of the project, which party will be responsible for this and for how long after completion of the project?

A33. The General Contractor and their subcontractors will be responsible for the Platipus Anchors. Installation of LiteEarth shall have a warranty by Installer against defects in workmanship for a period of 1 year from the date of project completion (County acceptance).

Q34. Please provide composite specs the engineer would like for us to bid to for the strips.

A34. The drainage geocomposite for the project shall be a bi-planar geonet with a thermally bonded, non-woven geotextile on both sides. Geotextile component shall be 6 oz\sy nonwoven, needle-punched, polyester or polypropylene geotextile. Geotextile properties shall meet or exceed the following: CRB Puncture of 300 lbs and Grab Tensile Strength of 155 lbs. The drainage net shall be a bi-planar High-density Polyethylene (HDPE) media with physical properties that meet or exceed the following:

Thickness: 330 ±30 mils
Tensile Strength (Machine Direction): 75 lbs./in.
Compressive Strength: 120 lbs./in.2
Transmissivity (composite): 1.5x10-3

Submittal with manufacturers description sheet required prior to use of proposed drainage geocomposite. No conformance testing required for drainage geocomposite components.

Q35. We are concerned about holding geosynthetic prices for 60+ days. On average, manufacturers hold it for 30. What can be done to mitigate this?

A35. See Addendum 2.

Q36. In regards to the phasing plan – is there a clear beginning and finish? Along with approx. acreage of each planned phase?

A36. Please refer to Technical Specification Section 2D item 1.2.2 Construction Element Phasing for additional information.

Q37. For the sand pump installer, they need access from the main road while working – delivery trucks and sand pump truck will have to work on the road for the duration of the project – can this access be confirmed?

A37. The work area for the Colton Closure Construction Project extends the entire area of the site property boundary and access within that work area will be dependent on construction activities and phasing as determined by the contractor. Additionally, review Technical Specifications Section 1 Item 1.13 for concurrent construction within the area.

Q38. Is there a clay or base material to go over the turf on the access road?

A38. There is no clay proposed as part of the access road sections. Please review Construction Drawing Detail 1 on Sheet D1, Detail 1 on Sheet D2, and Detail 2 on Sheet D5 for typical proposed access road sections. Please review Details 1-4 on Sheet D8 for typical proposed maintenance road sections.

Q39.Can you confirm that staging from all sides of the landfill is available?

A39. The work area for the Colton Closure Construction Project extends the entire area of the site property boundary and staging within that work area will be dependent on construction activities and phasing as determined by the contractor. Additionally, please review Technical Specifications Section 1 Item 1.13 for concurrent construction within the area.

Q40. In regards to grooming sand on the slopes steeper than 2.5:1 – there is available equipment to drive on slopes no steeper than 2.5, are we expected to hand groom or not groom all of the areas?

A40. If the Closure Turf System (Alternative "A") is chosen, grooming of the sand is required on all areas. It is the contractor's responsibility to determine means and methods to complete this and be compliant with the manufacturer's recommendation.

Q41. In regards to the Bid Alt "A", can the bid item 9A be combined with 10C and the bid item 9B be combined with 10D? The manufacturer quotes this as a system and not separate items. Therefore, these bid items will not be reflected accurately at the time of bidding if left like this

A41. Bid as shown in Bid Schedule.

Q42. For the type of product in bid Option B, we understand that 3rd-party conformance testing is normally only required for the components that contribute to barrier performance (e.g. the LLDPE geomembrane). Will individual component testing be required for any non-barrier components of the composite turf/geomembrane product (e.g. turf before lamination, lamination properties, etc.)? If so, will test results be reviewed and approved prior to using the components? What is the turnaround time for testing and review/approval of conformance test results?

A42. Yes – individual component conformance testing by a third-party laboratory will be required for this project, for both Alternatives and both barrier/non-barrier components. Testing frequency is described in the Technical Specifications.

Final approval of the geosynthetic component, by the Engineer/Construction Manager shall be contingent upon certification of test results which meet or exceed the requirements of the Technical Specifications. All conformance test results must be approved by the Engineer or Construction Manager prior to deployment/installation.

The following conformance test, at a minimum, will be required for Option B:

- **a. Geomembrane – Standard conformance testing for GM17 LLDPE**
- **b. Turf – Face weight (once per production run to confirm that turf blades are being trimmed to correct length. Turf blades pull back against the backing textile during lamination, so face weight is used as a proxy test for turf length.**
- **c. Lamination**
    - **i. Tuft bind (measures the force needed to use a tuft of turf blades from the product) – 3.0 lb, tested once per LLDPE master roll as MQC**

ii. **Delamination resistance (similar to geosynthetics ply adhesion, but tested with carpet industry test methods) – 2.7 lb/in tested once per LLDPE master roll in MQC.**

Third-party laboratory testing turnaround time will be determined by the contractor and the approved lab. The Engineer or Construction Manager shall respond with comments or approval within 5 working days of receipt of Conformance test results.

Q43. The geomembrane in bid Option A is normally manufactured with a 50-mil thickness, and the geomembrane in bid Option B is normally manufactured with a 40-mil LLDPE geomembrane as shown in the project plans. The plans show 40-mil for Bid-option B, but the specifications do not reference a thickness for the geomembrane in Bid Option B. Will the standard 40-mil thickness be used for the material in Bid Option B?

A43. Alternative A ClosureTurf product will use a 50-mil LLDPE Super Gripnet geomembrane Technical Specifications and CQA Plan have been updated as part of Addendum #3. Alternative B Solmax LiteEarth product will use a 40-mil LLDPE geomembrane.

Q44. Drawings GD9 & GD10 Gas Detail Sheets depicts the lateral piping being partially buried between extraction wells. It transitions below ground at all bench locations and daylights at mid-slope between benches. This design complicates the turf installation and, if the liner installation subcontractor is not installing the gas piping as well, it will necessitate the gas system installer to work on top of the previously install turf to complete the piping installation. By modifying the design and maintaining the laterals beneath the turf this situation would be eliminated along with numerous pipe penetration boots currently required at all transition points through the turf.

A44. Bid as shown. The design intent was to install as much of the LFG piping above grade as practical to allow for future access/maintenance. Transitioning pipe below grade at benches allows for truck access and also provides anchorage for the on-grade piping.

Q45. For the type of product in bid Option B, we understand that 3rd-party conformance testing is normally only required for the components that contribute to barrier performance (e.g. the LLDPE geomembrane). Will individual component testing be required for any non-barrier components of the composite turf/geomembrane product (e.g. turf before lamination, lamination properties, etc.)? If so, will test results be reviewed and approved prior to using the components? What is the turnaround time for testing and review/approval of conformance test results?

A45. See answer to question 42 above.

Q46. The geomembrane in bid Option A is normally manufactured with a 50-mil thickness, and the geomembrane in bid Option B is normally manufactured with a 40-mil LLDPE geomembrane as shown in the project plans. The plans show 40-mil for Bid-option B, but the specifications do not reference a thickness for the geomembrane in Bid Option B. Will the standard 40-mil thickness be used for the material in Bid Option B?

A46. See answer to question 43 above.

Q47. Can the engineer provide the required spacing on the Platipus Anchors required for Option B?

A47. See attached grid design for required spacing of Platipus Anchors.

Q48. Please clarify if 15,000 cy discussed in item 7D are paid under Item 7C (import)? I understand that 15,000 cy is **not additional** quantities to 7A, 7B, and 7C.

A.48 It is estimated that 15,000 cy of import material is needed for backfill and compaction of erosion gullies and rills, removing surface irregularities, scarifying or smoothing, and other work needed to prepare the subgrade. This 15,000 cy is included in Pay Item 7D and must be accounted for in the 4,000,000 SF of subgrade preparation. The 15,000cy is not paid under 7C Import. Estimated Quantity for Pay Item 7D is revised from 400,000 SF to 4,000,000 SF, see revised Bid Schedule.

The addition of these requirements shall be considered in concert with existing documents in preparation of bids. If you have any questions, please contact Johnny Gayman at (909) 386-8688.

Marc A. Rodabaugh

MARC RODABAUGH, P.E.,
Solid Waste Management Division

BID SCHEDULE ADDENDUM 5

Item No.	Description	QTY	Unit	Cost	Total
BID ITEMS 1 THROUGH 8B - (COMPLETE FOR BOTH ALTERNATIVES)					
1	MOBILIZATION	1	LS		
2	CONSTRUCTION SUPPORT TASKS - SWPPP COMPLIANCE - CONSTRUCTION ACTIVITIES STORMWATER MANAGEMENT PLAN (CASMP) - INTERIM EROSION CONTROL AND BMP'S	1	LS		
3	PROJECT SURVEY (INCLUDES SETTLEMENT MONUMENT SURVEY)	1	LS		
4	RECORD DRAWINGS	1	LS		
SUBTOTAL BID ITEMS 1 THRU 4 - (COMPLETE FOR BOTH ALTERNATIVES)			$		
5	CLEARING, GRUBBING, AND DEMOLITION	90.0	AC		
6A	EXCAVATE REFUSE, LOAD, AND TRANSPORT, TO RECONSOLIDATION AREA	20,000	CY		
6B	BACKFILL AND COMPACTION OF REFUSE EXCAVATION AREAS USING IMPORT SOIL	20,000	CY		
7A	UNCLASSIFIED EXCAVATION TO FOUNDATION FILL (SOUTH BASIN)	23,000	CY		
7B	UNCLASSIFIED EXCAVATION TO FOUNDATION FILL - COVER SOIL TRIM	4,500	CY		
7C	FOUNDATION FILL SLOPES AND BENCHES (IMPORT)	120,000	CY		
7D	SUBGRADE PREPARATION FOR FINAL COVER GEOSYNTHETICS INSTALLATION	4,000,000	SF		
8A	CONSTRUCT GABION WALL (TYPE A) (1-FOOT)	840	LF		
8B	CONSTRUCT GABION WALL (TYPE B) (3-FOOT)	906	LF		
SUBTOTAL BID ITEMS 5 THRU 8B - (COMPLETE FOR BOTH ALTERNATIVES)			$		

CLOSURETURF- ALTERNATIVE "A" - (BID ONLY ONE ALTERNATIVE)					
9A	50 MIL LLDPE SUPER GRIP NET GEOMEMBRANE (SLOPES/BENCHES) (PER DETAIL 1/D1)	4,000,000	SF		
9B	50 MIL LLDPE SUPER GRIP NET GEOMEMBRANE (DECK) (PER DETAIL 1/D1)	100,000	SF		
9C	CONSTRUCT ANCHOR TRENCH (PER DETAIL 3/D2, 4/D2, 2/D7, AND 7/D7)	2,800	LF		
9D	LINER TERMINATION ANCHOR - EXTRUSION WELD AT TRI-LOCK EMBEDMENT STRIP/BATTEN STRIP (PER DETAILS 4/D5, 1/D6, 2/D6, AND 3/D6)	180	LF		
9E	DRAINAGE ROAD ANCHORS (PER DETAIL 1/D5)	800	LF		
9F	EASTERLY PERIMETER ROAD ANCHOR (PER DETAIL 1/D2)	1,500	LF		
9G	SOUTHWEST BASIN ANCHOR TRENCH (PER DETAIL 5/D7)	600	LF		
10A	DOWNDRAIN TO BENCH CROSSING/DOWNDRAIN TRANSITION SUBGRADE (PER DETAIL 5/D1 AND DRAWING SHEET NUMBERS D9, D10, AND D11)	35,000	SF		
10B	DOWNDRAIN GRADING, SUBGRADE PREPARATION, AND SAND OR CMB FILLETS (b=10', D=1.17') (PER DETAIL 4/D1)	40,000	SF		
10C	CLOSURE TURF (SLOPES/BENCHES) (PER DETAIL 1/D1)	4,000,000	SF		
10D	CLOSURE TURF (DECK) (PER DETAIL 1/D1)	100,000	SF		
10E	INSTALL SAND INFILL PER MANUFACTURER'S RECOMMENDATIONS (PER DETAIL 1/D1)	4,000,000	SF		
10F	HYDRO BINDER INFILL	35,000	SF		
SUBTOTAL BID ITEMS 9A THROU 10F - CLOSURETURF (ALTERNATIVE "A" ONLY)			$		

LITEEARTH - ALTERNATIVE "B" - (BID ONLY ONE ALTERNATIVE)					
9A	40 MIL LLDPE GEOMEMBRANE WITH INTEGRAL TURF (SLOPES/BENCHES) (PER DETAIL 1/D1)	4,000,000	SF		
9B	40 MIL LLDPE GEOMEMBRANE WITH INTEGRAL TURF (DECK) (PER DETAIL 1/D1)	100,000	SF		
9C	CONSTRUCT ANCHOR TRENCH (PER DETAILS 3/D2, 4/D2, 2/D7, AND 7/D7) (NO GEOCOMPOSITE DRAIN)	2,800	LF		
9D	LINER TERMINATION ANCHOR - EXTRUSION WELD AT TRI-LOCK EMBEDMENT STRIP (PER DETAILS 4/D5, 1/D6, 2/D6, AND 3/D6) (NO BATTEN STRIP)	180	LF		
9E	DRAINAGE ROAD ANCHORS PER DETAIL 1/D5 - (NO GEOCOMPOSITE DRAIN)	800	LF		
9F	EASTERLY PERIMETER ROAD ANCHOR PER DETAIL 1/D2 - (NO GEOCOMPOSITE DRAINS)	1,500	LF		
9G	SOUTHWEST BASIN ANCHOR TRENCH PER DETAIL 5/D7 - (NO GEOCOMPOSITE DRAIN)	600	LF		
10A	DOWNDRAIN TO BENCH CROSSING/DOWNDRAIN TRANSITION SUBGRADE (PER DETAIL 5/D1 AND DRAWING SHEET NUMBERS D9, D10, AND D11)	35,000	SF		
10B	DOWNDRAIN GRADING, SUBGRADE PREPARATION,AND SAND OR CMB FILLETS (b=10', D=1.17') (PER DETAIL 4/D1)	40,000	SF		
10G	PLATIPUS ANCHORS	20,450	EA		
SUBTOTAL BID ITEMS 9A THRU 10B AND 10G - LITEEARTH (ALTERNATIVE "B" ONLY)			$		

BID ITEMS 10H THROUGH 26C - (COMPLETE FOR BOTH ALTERNATIVES)					
10H	BENCH ROCK BALLAST OVER FINAL COVER SYSTEM (PER DETAIL 1/D7)	500,000	SF		
11A	ASPHALT THICKENED EDGE (PER DETAIL 4/D7)	900	LF		
11B	4" AC OVER 6" CMB ACCESS ROAD/ROADWAY DRAINAGE SWALE (PER DETAIL 3/D1)	140,000	SF		
11C	4" AC OVER 6" CMB EAST PERIMETER ROAD WITH ROADWAY DRAINAGE SWALE (PER DETAIL 1/D2)	33,000	SF		
11D	4" AC OVER 6" CMB PAVED ALL WEATHER ACCESS BENCH WITH CMB KICKERS (PER DETAIL 2/D5)	17,000	SF		
11E	CONSTRUCT 15-FOOT WIDE DRAINAGE ROAD WITH LLDPE/CT ANCHORS (PER DETAIL 1/D5)	8,000	SF		
11F	ITEM INTENTIONALLY LEFT BLANK				
11G	CONSTRUCT 6" CMB OVER 12 OZ/SY GEOTEXTILE SOUTH CHANNEL ACCESS ROAD (PER DETAILS 3/D2 OR 4/D2)	30,000	SF		
11H	CONSTRUCT AC CURB TYPE D-2(6) (PER SPPWC STD PLAN 121-1)	4,750	LF		
11I	4" AC OVER 6" CMB AC ROADWAY TRANSITION FROM DOWNDRAIN TO GABION (PER DETAIL 2/D7)	2,000	SF		
11J	4' AC OVER 6" CMB AC BENCH APRON TRANSITION TO ACCESS ROAD	9,000	SF		
12A	CONCRETE TRAP. CHANNEL INLET TRANS. (b=5.0' D=2.0' Z=1 TO b=1.0' D=2.0' Z=1)	10	LF		
12B	CONCRETE TRAPEZOIDAL CHANNEL/FINAL COVER TERMINATION (b=1.0' D=2.0' Z=1) (PER DETAIL 7/D1)	580	LF		
13A	INSTALL N12 24-INCH DIAMETER HALF-ROUND PIPE DOWNDRAIN BERMS (PER DETAIL 2/D1)	8,200	LF		
13B	INSTALL SOLID HDPE 12-INCH DIAMETER SDR 17 STORM DRAIN PIPE (PER DETAIL 6/D8)	260	LF		
14	CONSTRUCT CONCRETE HEADWALL/OUTLET APRON TO 36" SPIRAL RIB PIPE W/ WARPED WING WALLS PER CALTRANS STD D86B (PER DETAILS 1/D4, 2/D4, 3/D4, AND 1/D6)	3	EA		

15	CONSTRUCT GATE/FENCE/AC PAVEMENT ACCESS/GROUTED RIP RAP ENHANCEMENTS TO DRAINAGE OUTLET 4 (PER DETAIL 4/D5)	1	LS		
16	CONSTRUCT GATE AND FENCE/AC PAVEMENT ACCESS/GROUTED RIP RAP ENHANCEMENTS TO DRAINAGE OUTLET 5 (PER DETAIL 5/D5)	1	LS		
17	INSTALL INCLINED TRASH RACK (PER SPPWC STD PLAN 361-2)	5	EA		
18	GROUTED RIP RAP AND GROUTED GABION ROCK (PER DETAILS 6/D1 AND 2/D7)	600	SF		
19	SETTLEMENT MONUMENTS (PER DETAIL 6/D7)	5	EA		
20	CLASS 1 FLEXIBLE POST DELINEATORS (SURFACE MOUNT) (PER CALTRANS STD A73C)	7	EA		
21A	6-FOOT CHAIN LINK FENCE (PER SPPWC STD PLAN 600-3)	2,500	LF		
21B	6-FOOT CHAIN LINK 15-FOOT SWING GATE (PER SPPWC STD PLAN 600-3)	15	LF		
21C	8-FOOT CHAIN LINK FENCE (PER CALTRANS STD A85)	1,000	LF		
21D	8-FOOT SALVAGED CHAIN LINK SWING GATE (REMOVAL/SALVAGE/RE-INSTALL) (PER CALTRANS STD A85)	66	LF		
22A	CONCRETE APRON/CHANNEL (MATCH EXISTING) 4" CONCRETE W/6" BY 6" - #10 BY #10 WWM REINFORCING	180	SF		
22B	6-INCH THICK CONCRETE ACCESS RAMP/DRAINAGE OUTLET PAVEMENT WITH #4 BARS AT 12-INCHES ON CENTER EACH WAY OVER 4-INCHES CMB AGAINST 10-INCH SUBGRADE KICKER WITH INTEGRAL 8-INCH CONCRETE CURB	1,100	SF		
23A	CONSTRUCT MAINTENANCE ROAD BRIDGE CROSSING (PER DETAILS 4/D5, 1/D6, 2/D6, AND 3/D6)	4	EA		
23B	ADDITIONAL MAINTENANCE ROAD BRIDGE CROSSING SUPPORTS AT ROAD EDGE (PER DETAIL 3/D6)	10	CY		
24A	CONSTRUCT TYPE 1 MAINTENANCE ROAD (PER DETAIL 4/D3)	1,500	LF		
24B	CONSTRUCT TYPE 2 MAINTENANCE ROAD (PER DETAILS 1/D3 AND 3/D3)	1,800	LF		
24C	CONSTRUCT TYPE 3 MAINTENANCE ROAD (PER DETAIL 5/D8)	500	LF		

24D	CONSTRUCT TYPE 3 MAINTENANCE ROAD (8-INCH OR 2-INCH TO 8-INCH CURB FACE TRANSITION PER DETAIL 4/D8)	100	LF		
25	CABLE RAILING PER CALTRANS STD. PLAN B11-47 - ATTACH TO BRIDGE CROSSING SUPPORTS OR CAST 2-FOOT DEEP IN UNDERLYING CONCRETE SURFACE	50	LF		
26	EROSION CONTROL/FINAL STABILIZATION	1	LS		
26A	FIBER ROLLS	1,000	LF	**PAID FOR IN BID ITEM 26**	
26B	GRAVEL BAG CHEVRONS	21	EA		
26C	HYDROSEED	0.85	AC		
SUBTOTAL BID ITEMS 10H THROUGH 26C - (COMPLETE FOR BOTH ALTERNATIVES)			$		
LFG BID ITEMS G1 THROUGH G27 - (COMPLETE FOR BOTH ALTERNATIVES)					
G1A	LFG WELL DRILLING AND INSTALLATION PER DETAIL 1/GD11	6,251	VF		
G1B	VERTICAL WELL BORING ABANDONMENT	500	VF		
G2	2-INCH VERTICAL WELLHEAD ASSEMBLY PER DETAIL 5/GD12, 2/GD14	56	EA		
G3A	12-INCH HDPE HEADER, AIR, FORCEMAIN IN COMMON TRENCH PER DETAIL 7/GD7	480	LF		
G3B	12-INCH HDPE HEADER, AIR, FORCEMAIN, 4-INCH PERF PIPE IN COMMON TRENCH PER DETAILS 7/GD1, 1/GD2, 3/GD2, 4/GD2	3,800	LF		
G4	8-INCH HDPE HEADER, AIR, FORCEMAIN, 4-INCH PERF PIPE, IN COMMON TRENCH PER DETAILS 1/GD3, 3/GD3, 4/GD3	3,000	LF		
G5	8-INCH HDPE HEADER, 4-INCH PERF PIPE IN COMMON TRENCH PER DETAIL 5/GD7	400	LF		
G6	4-INCH PERFORATED PIPE PER DETAIL 1/GD5	550	LF		
G7	8-INCH BELOW GRADE HEADER AND GEOCOMPOSITE DRAINAGE STRIP IN ACCESS ROAD PER DETAIL 3/GD1	4,400	LF		
G8	8-INCH BELOW GRADE HEADER ON SLOPE PER DETAIL 6/GD8	750	LF		
G9	CONDENSATE SUMP TYPE 1 PER 1/GD13	2	EA		
G10	CONDENSATE SUMP TYPE 2 PER 2/GD13	3	EA		
G11	CONDENSATE SUMP TYPE 3 PER 3/GD13	1	EA		
G13	WELL ABANDONMENT PER DETAIL 6/GD11	171	EA		
G14	REMOVE AND DISPOSE OF PIPE PER PROJECT LFG TRANSITION SPECIFICATIONS	90	AC		

G15	LFG REMOTE WELL PIPING PER 5/GD12, 1/GD10	1,850	LF		
G16A	GEOCOMPOSITE COLLECTION STRIPS PER PLAN AND DETAIL 5/GD14	4,000	LF		
G16B	SURFACE COLLECTION WELL PER DETAIL 5/GD14, 3/GD14	9	EA		
G17	PRESSURE RELIEF VALVE PER DETAIL 6/GD14	50	EA		
G18	TOE COLLECTOR GAS WELL PER DETAIL 4/GD14	14	EA		
G19	6-INCH HDPE LATERALS PER 1/GD9	7,400	LF		
G20	12-INCH VALVE PER 2/GD12	1	EA		
G21	8-INCH VALVE PER 2/GD12	4	EA		
G22	6-INCH HDPE POLY VALVE 1/GD9	25	EA		
G23	2-INCH AIR ISOLATION VALVE ASSEMBLY PER DETAIL 2/GD15	2	EA		
G24	3-INCH FM ISOLATION VALVE ASSEMBLY PER DETAIL 1/GD15	2	EA		
G25	BELOW GRADE BENCH CROSSING FOR 6-INCH HDPE LATERAL PER DETAIL 1/GD9, 1GD/10	65	EA		
G26	12-INCH TIE-IN TO EXISTING SUMP 1	1	EA		
G27	GEOCOMPOSITE STRIPS IN DOWNDRAIN TRANSITION TO BENCH CROSSINGS PER DETAIL 5/GD1	38	EA		

SUBTOTAL BID ITEMS 1 THRU 4 - (COMPLETE FOR BOTH ALTERNATIVES)	**$**
SUBTOTAL BID ITEMS 5 THRU 8B - (COMPLETE FOR BOTH ALTERNATIVES)	**$**
SUBTOTAL BID ITEMS - CLOSURETURF (ALTERNATIVE "A" ONLY) (ITEMS 9A THRU 10F) *OR* LITEEARTH (ALTERNATIVE "B" ONLY) (ITEMS 9A THRU 10B AND 10G)	**$**
SUBTOTAL BID ITEMS 10H THROUGH 26C - (COMPLETE FOR BOTH ALTERNATIVES)	**$**
SUBTOTAL BID ITEMS G1 THROUGH G27 - (COMPLETE FOR BOTH ALTERNATIVES)	**$**
TOTAL BASE BID =	**$**

SWMD reserves the right to delete any specific item on the bid schedule in its entirety. Should SWMD elect not to proceed with a specified item of work, it will be deleted from the contract. Section 3-2.1 of the SSPWC shall not apply to Item numbers 6A, 6B, 7A, 7B, 7C, 10G and G1B. The Contractor shall have no claim for compensation, or loss of profit, as a result of the deletion or reduction in quantities.

The Bid Schedule shown above does not constitute agreed-upon costs for the items described. The purpose of this cost breakdown is to provide SWMD with cost allocations for comparison and budgeting purposes only. Final cost allocations for each individual item for the project's schedule of values and progress payments will be established by the Construction Manager in negotiation with the Contractor.

THE AWARD OF THIS CONTRACT WILL BE BASED ON THE LOWEST RESPONSIBLE BID TOTAL.

FIGURE 1
IMPORT SOURCE LOCATION

UNIT 5 AREA

UNIT 3 AREA

UNIT 2 AREA

APPROXIMATE LIMITS OF
APPROVED MATERIAL STOCKPILE

UNIT 6/7 AREA

UNIT 1 AREA

UNIT 4 AREA
(ACTIVE LANDFILL)

SCALES AND
SCALE HOUSE

SITE ENTRANCE
FACILITY/ROAD

SITE ENTRANCE

MID-VALLEY DISPOSAL SITE

(BASED ON LEGACY LANDFILL SITE CONTROL)

UAS FLIGHT DATE: 01/04/2022
JL 6062 WO # R50260

200 100 0 200 400 600
SCALE: 1"=200'

FIGURE 1

COLTON FINAL CLOSURE CONSTRUCTION PROJECT – ADDENDUM #4

MID-VALLEY LANDFILL APPROVED IMPORT SOURCE

SITE PLAN

PREPARED BY:
SWT Civil & Environmental Engineering
800-C ROCHESTER AVE.
ONTARIO, CALIFORNIA. 91761

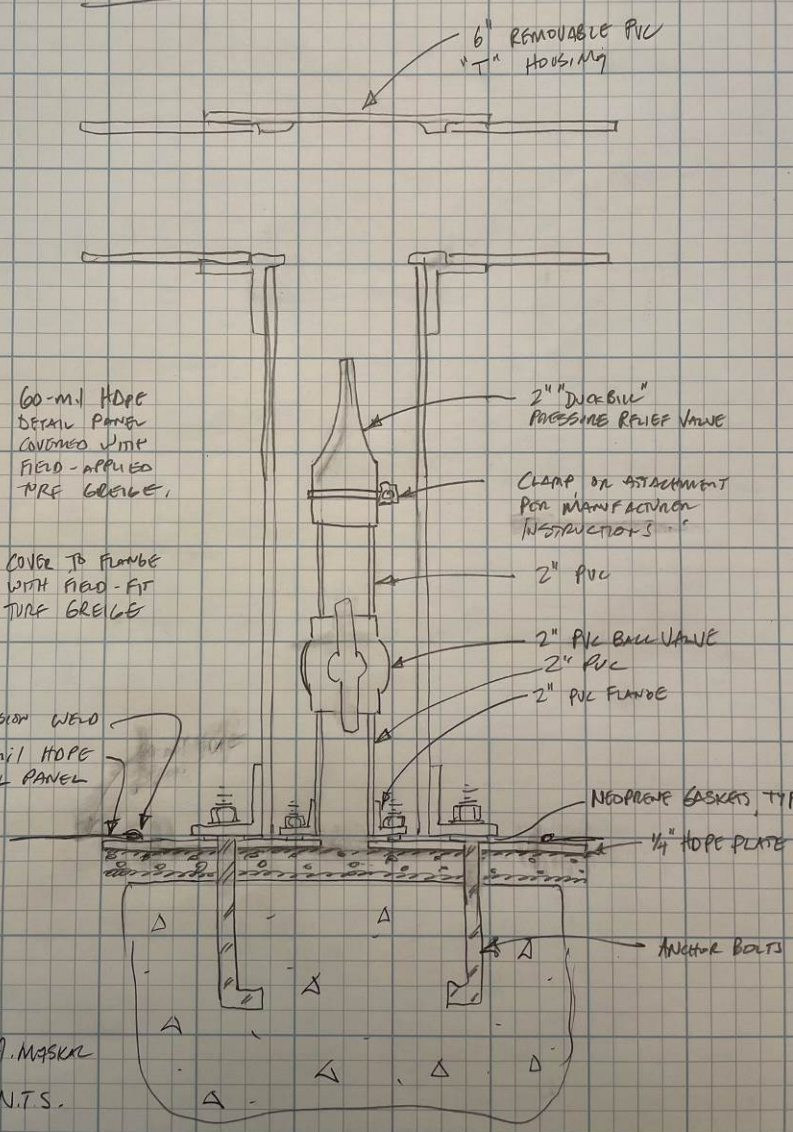
AERIAL TOPOGRAPHY PROVIDED BY SAN BERNARDINO COUNTY
DATE OF TOPOGRAPHY: JANUARY 4, 2022

JUNE 2022

Z:\PROJECTS\SAN BERNARDINO SWMD\COLTON\FINAL CLOSURE CONSTRUCTION DRAWINGS\BID PROCESS\ADDENDUM 4\FIG01-MVSL IMPORT SOUCE SITE MAP

LiteEarth
Pressure Relief Valve
Design

LITE EARTH PRESSURE RELIEF VALVE



DRAWN: A. MASKAL

SCALE: N.T.S.

Grid Design for Platapus Anchors

HARTMAN ENGINEERING

Client:	Solmax	**By:**	Craig Hartman, PE
Project:	Solmax	**Date:**	6/13/2022
Calculations For:	Anchor Design for 40 mil LLDPE	**Project No.:**	22007

Design Code and Refernces

[1] California Building Code (2019)
[2] Uplift of Geomembranes by Wind, Giroud et al. (1995)
[3] Wind Tunnel Study and Uplift Analysis of Geosynthetic Covers, M. Zhu et al. (2022)
[4] Wind Uplift Calculation for Exposed Geomembranes: an Enhanced Design Methodology. C. Li et al. (2016)
[5] Technical Data Sheet. LLDPE Series, 40 mil Black, Textured. Solmax (2018)
[6] Platipus R&D Test Record TR 502 (2017)

Given Information

1. Design Wind Load

V =	115	mph	Basic design wind speed [1]
Site =	San Bernardino, CA		Site location
V' =	69.3	mph	Reduced wind speed over 600 second, V' = V/1.66 (or 0.6*V) [4]
V_{sus} =	80.0	mph	Sustained wind velocity, V_{sus} ≈ V / 1.44 (or 0.7*V)

Note: Sustained wind velocity that has a slightly larger value than V' will be used for uplift calculations . The basic design wind speed (3-second gust speed at 33 ft (10 m) above the ground in Exposure C category) [1] and the reduced wind speed over 600 second [4] were only used for estimate of sustained wind speed. System is designed for the nominal wind condition, applied uniformly over the entire site area. The anchorage system has not been designed for localized gusts in excess of the nominal wind speed. Localized gusts in excess of the design wind speed may damage parts of the system, requiring local repairs.

2. Geomembrane Properties

Per material technical data sheet [5], the geomembrane properties are listed below:

Type =	40 mil LLDPE Textured		Geomembrane type
t_{gm} =	40	mil	Minimum geomembrane thickness
δ_{gm} =	0.939	g/cm^3	Geomembrane density
T_{u_gm} =	100	lb/in	Tensile strength at break
ε_{u_gm} =	250	%	Elongation at break
J =	2400	lb/in	2% modulus

3. Anchor Properties

Per test record [6], the anchor strength is:

T_{ult} =	2000	lb	Ultimate pullout load of platipus anchor

4. Site Info

Accoding to Figure 1, the steepest slope in the overall area appears at the shortest horizontal distance between the top crest and the bottom of the landfill area

Δh =	561.42	ft	Est. shortest horizontal distance, i.e. the radius in Figure 1
v_{r_top} =	1168	ft	Top crest elevation within the radius, see Figure 1
v_{r_bottom} =	980	ft	Bottom elevation within the radius, see Figure 1
Δv =	188	ft	Est. vertical distance, $\Delta v = v_{r\_top} - v_{r\_bottom}$

$\Delta h : \Delta v$ =	2.99	: 1	Deepest slope ratio per Figure 1
≈	3	: 1	Design slope ratio

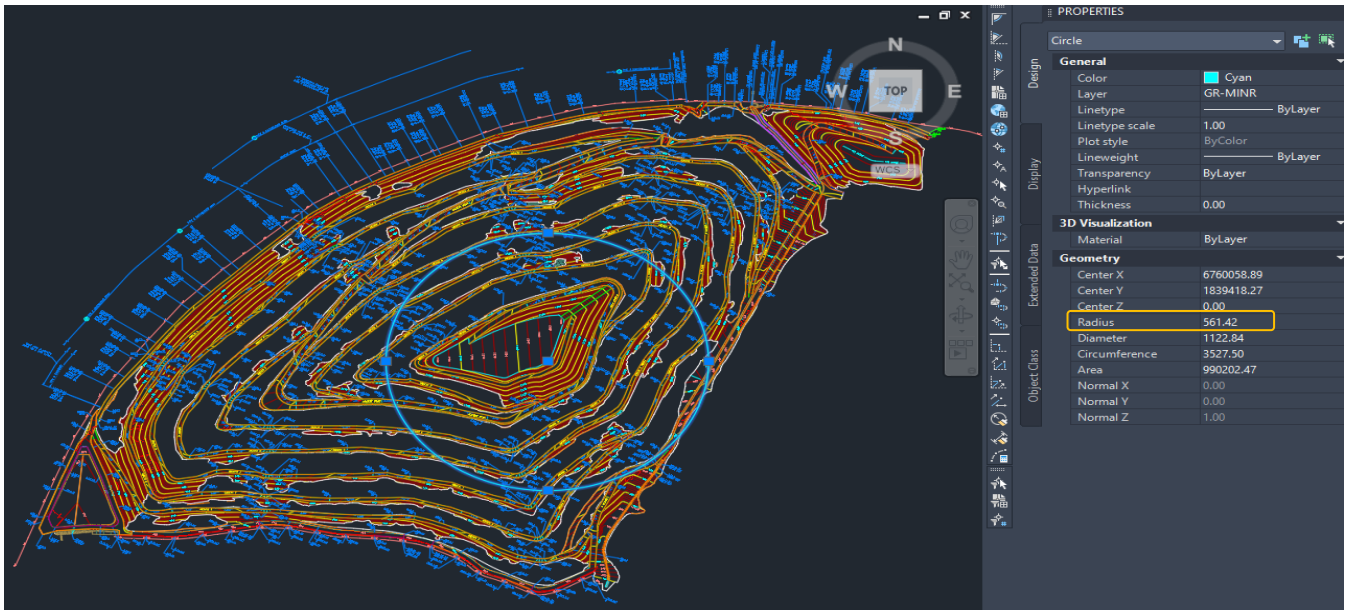


Figure 1 Site plan view, screenshot from CAD

Calculations

1. Assumptions

1.(a). Geomembrane is substantially flat and the effects of temperature variation have not been included

1.(b). Engineered turf layer will be covered above the designed geomembrane

1.(c). Assumed Design Parameters

FS_{gm} =	3.0	Factor of safety for geomembrane
FS_{anch} =	1.3	Factor of safety for platipus anchor

2. Geomembrane Sensitivity to Wind Uplift

Check the need for uplift design [2]

z =	0.0	ft	At altitude above sea level (most conservative)
λ =	1.0		Suction factor (at crest, most conservative)

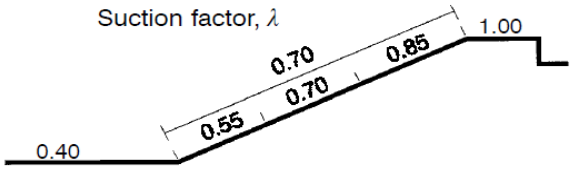


Figure 2 Recommended values of suction factor [2]

μ_{gm} =	0.954	kg/m^2	Mass per unit area of geomembrane, $\mu_{gm} = \delta_{gm} * t_{gm}$
μ_{gm_req} =	84.287	kg/m^2	Req'd mass per unit area of gmb., $\mu_{gm\_req} = 0.0659 * \lambda * V_{sus}^2$ [2]

Since μ_{gm}	**<**	**μ_{gm_req} ,**	**geomembrane would be uplifted, needs to consider wind uplift**

3. Anchor Design

According to M. Zhu et al. (2022), the suction factor λ recommended by Giroud et al. [3] did not account for variation in surface roughness of geomembrane nor the slope ratio. Therefore, a series of wind tunnel studies and uplift analyses were conducted and the measured maximum wind uplift pressure coefficients are suggested in Table 1 [2].

Table 1 Measured max. wind uplift pressure coefficients

Cover Type	3H:1V Slope [3]	4H:1V Slope [3]	Giroud's Solution	Modified Giroud's Solution
Smooth Exposed Geomembrane Cover	1.24	1.13	1	0.77
Rough, "Studded" Exposed Geomembrane Cover	0.6	N/A		
LiteEarth Engineered Turf Cover	0.38	0.29	N/A	N/A

The suggested equation to find out the max wind uplift pressure at designated elevation [3]:

$P = C_p * 0.5 * \rho * V(z)^2$

$V(z) = V_{ref} * (z/z_{ref})^{\alpha}$

where

C_p =	0.38		Wind pressure coefficient when slope ratio = 3H : 1V, Table 1
ρ =	0.00237	slug/ft^3	Air density at 15 ^{o}C and sea level
z_{ref} =	32.8	ft	Reference 3-sec gust speed elevation of basic wind speed [1]
V_{ref} =	117.33	ft/s	Mean wind speed at z = 32.8 ft, $V_{ref} = V_{sus}$, unit conversion
α =	0.14		Parameter, see Figure 3

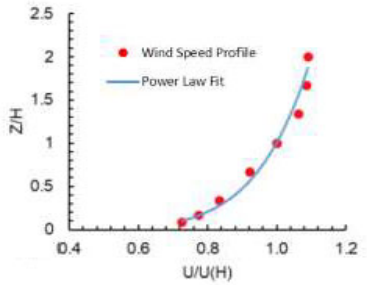


Figure 3 Measured wind speed profile and power-law curve fit

3.(a). Top Crest Anchorage Design

Design for anchor spacing

v_{top} =	1168	ft		Highest elevation of the current design section
v_{bottom} =	900	ft		Lowest elevation of the entire site
z =	268	ft		Elevation above bottom, $z = v_{top} - v_{bottom}$
V(268) =	157.45	ft/s		Mean wind speed at elevation z, $V(z) = V_{ref} * (z/z_{ref})^{\alpha}$
P =	**11.16**	**psf**		Max wind uplift pressure, $P = C_p*0.5*\rho*V(z)^2$
T_{a_anch} =	1538.46	lb		Allowable pullout load of platipus anchor, $T_{a\_anch} = T_{ult}/FS_{anch}$
A_{max} =	137.82	ft^2		Max area that may be held down by an anchor, $A_{max} = T_{a\_anch}/P$
S_{h_anch} =	**9.50**	**ft**		Design anchor spacing in horizontal direction
S_{v_anch} =	**14.50**	**ft**		Design anchor spacing in vertical direction
A_{anch} =	137.75	ft^2	OK	Provided anchor hold down area

Check for geomembrane strain

L =	17.33	ft	Chord between two anchors, $L = 2*\sqrt{((0.5S_{h\_anch})^2+(0.5S_{v\_anch})^2)}$
F =	193.51	lb/ft	Resultant uplift force, F = P*L

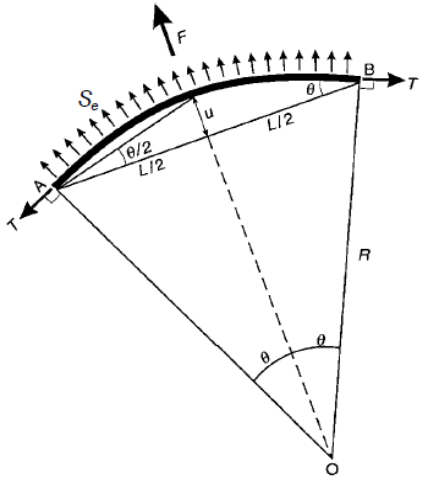


Figure 4 Schematic representation of uplifted geomembrane [2]

Giroud et al. suggested the following equation to find out the strain in geomembrane for the case of a geomembrane with a linear tension-strain curve [2]:

$S_e * L/(2*J*\varepsilon) = \sin[S_e * L/(2*J)*(1+1/\varepsilon)]$

In this project, with the use of engineered turf cover, the max wind uplift pressure (P) is used instead of the effective suction (S_e) in the equation, thus the modified equation is:

$P*L/(2*J*\varepsilon) = \sin[P*L/(2*J)*(1+1/\varepsilon)]$

When ε =	1.25	%	< allowable strain	$\varepsilon_{u\_gm}/FS_{gm}$ = 83.33 %	OK
$P*L/(2*J*\varepsilon)$ =		0.2688	The left term of the modified equation		
$\sin[P*L/(2*J)*(1+1/\varepsilon)]$ =		0.2688	The right term of the modified equation = the left term		OK

T_{gm} =	360.00	lb/ft	Tension of the uplifted geomembrane, $T_{gm} = J*\varepsilon$
u =	1.19	ft	Uplift height of geomembrane
θ =	15.59	deg	Angle between gmb. and supporting soil, $\theta = \sin^{-1}(P*L/(2*T_{gm}))$

Design anchorage spacing for Top Crest:

@ 9.50 ft on center in one direction

@ 14.50 ft on center in the orthogonal direction

3.(b). Slopes above Bench #6 Anchorage Design

Design for anchor spacing

v_{top} =	1150	ft		Highest elevation of the current design section
v_{bottom} =	900	ft		Lowest elevation of the entire site
z =	250	ft		Elevation above bottom, $z = v_{top} - v_{bottom}$
V(250) =	155.92	ft/s		Mean wind speed at elevation z, $V(z) = V_{ref} * (z/z_{ref})^{\alpha}$
P =	**10.95**	**psf**		Max wind uplift pressure, $P = C_p*0.5*\rho*V(z)^2$
T_{a_anch} =	1538.46	lb		Allowable pullout load of platipus anchor, $T_{a\_anch} = T_{ult}/FS_{anch}$
A_{max} =	140.53	ft^2		Max area that may be held down by an anchor, $A_{max} = T_{a\_anch}/P$
S_{h_anch} =	**9.50**	**ft**		Design anchor spacing in horizontal direction
S_{v_anch} =	**14.50**	**ft**		Design anchor spacing in vertical direction
A_{anch} =	137.75	ft^2	OK	Provided anchor hold down area

Check for geomembrane strain

L =	17.33	ft	Chord between two anchors, $L = 2*\sqrt{((0.5S_{h\_anch})^2+(0.5S_{v\_anch})^2)}$
F =	189.78	lb/ft	Resultant uplift force, F = P*L

In this project, with the use of engineered turf cover, the modified equation is:

$P*L/(2*J*\varepsilon) = \sin[P*L/(2*J)*(1+1/\varepsilon)]$

When ε =	1.23	%		< allowable strain	$\varepsilon_{u\_gm}/FS_{gm}$ = 83.33 % OK
$P*L/(2*J*\varepsilon)$ =		0.2679	The left term of the modified equation		
$\sin[P*L/(2*J)*(1+1/\varepsilon)]$ =		0.2679	The right term of the modified equation = the left term		OK
T_{gm} =	354.24	lb/ft		Tension of the uplifted geomembrane, $T_{gm} = J*\varepsilon$	
u =	1.18	ft		Uplift height of geomembrane	
θ =	15.54	deg		Angle between gmb. and supporting soil, $\theta = \sin^{-1}(P*L/(2*T_{gm}))$	

Design anchorage spacing for solpes Above Bench #6:		
@	**9.50**	**ft on center in one direction**
@	**14.50**	**ft on center in the orthogonal direction**

3.(c). Slopes between Benches #3 and #6 Anchorage Design

Design for anchor spacing

v_{top} =	1050	ft		Highest elevation of the current design section
v_{bottom} =	900	ft		Lowest elevation of the entire site
z =	150	ft		Elevation above bottom, $z = v_{top} - v_{bottom}$
V(150) =	145.16	ft/s		Mean wind speed at elevation z, $V(z) = V_{ref} * (z/z_{ref})^{\alpha}$
P =	**9.49**	**psf**		Max wind uplift pressure, $P = C_p*0.5*\rho*V(z)^2$
T_{a_anch} =	1538.46	lb		Allowable pullout load of platipus anchor, $T_{a\_anch} = T_{ult}/FS_{anch}$
A_{max} =	162.14	ft^2		Max area that may be held down by an anchor, $A_{max} = T_{a\_anch}/P$
S_{h_anch} =	**11.00**	**ft**		Design anchor spacing in horizontal direction
S_{v_anch} =	**14.50**	**ft**		Design anchor spacing in vertical direction
A_{anch} =	159.50	ft^2	OK	Provided anchor hold down area

Check for geomembrane strain

L =	18.20	ft	Chord between two anchors, $L = 2*\sqrt{((0.5S_{h\_anch})^2+(0.5S_{v\_anch})^2)}$
F =	172.70	lb/ft	Resultant uplift force, F = P*L

In this project, with the use of engineered turf cover, the modified equation is:

$P*L/(2*J*\varepsilon) = \sin[P*L/(2*J)*(1+1/\varepsilon)]$

When ε =	1.15	%		< allowable strain $\varepsilon_{u\_gm}/FS_{gm}$ = 83.33 % OK
$P*L/(2*J*\varepsilon)$ =		0.2607		The left term of the modified equation
$\sin[P*L/(2*J)*(1+1/\varepsilon)]$ =		0.2607		The right term of the modified equation = the left term OK
T_{gm} =	331.2	lb/ft		Tension of the uplifted geomembrane, $T_{gm} = J*\varepsilon$
u =	1.21	ft		Uplift height of geomembrane
θ =	15.11	deg		Angle between gmb. and supporting soil, $\theta = \sin^{-1}(P*L/(2*T_{gm}))$

Design anchorage spacing for slopes Between Benches #3 and #6:

@ 11.00 ft on center in one direction

@ 14.50 ft on center in the orthogonal direction

3.(d). Slopes below Bench #3 Anchorage Design

Design for anchor spacing

v_{top} =	960	ft		Highest elevation of the current design section
v_{bottom} =	900	ft		Lowest elevation of the entire site
z =	60	ft		Elevation above bottom, $z = v_{top} - v_{bottom}$
V(60) =	127.69	ft/s		Mean wind speed at elevation z, $V(z) = V_{ref} * (z/z_{ref})^{\alpha}$
P =	**7.34**	**psf**		Max wind uplift pressure, $P = C_p*0.5*\rho*V(z)^2$
T_{a_anch} =	1538.46	lb		Allowable pullout load of platipus anchor, $T_{a\_anch} = T_{ult}/FS_{anch}$
A_{max} =	209.56	ft^2		Max area that may be held down by an anchor, $A_{max} = T_{a\_anch}/P$
S_{h_anch} =	**14.00**	**ft**		Design anchor spacing in horizontal direction
S_{v_anch} =	**14.50**	**ft**		Design anchor spacing in vertical direction
A_{anch} =	203.00	ft^2	OK	Provided anchor hold down area

Check for geomembrane strain

L =	20.16	ft	Chord between two anchors, $L = 2*\sqrt{((0.5S_{h\_anch})^2+(0.5S_{v\_anch})^2)}$
F =	147.97	lb/ft	Resultant uplift force, F = P*L

In this project, with the use of engineered turf cover, the modified equation is:

$P*L/(2*J*\varepsilon) = \sin[P*L/(2*J)*(1+1/\varepsilon)]$

When ε =	1.05	%		< allowable strain $\varepsilon_{u\_gm}/FS_{gm}$ = 83.33 % OK
$P*L/(2*J*\varepsilon)$ =		0.2447		The left term of the modified equation
$\sin[P*L/(2*J)*(1+1/\varepsilon)]$ =		0.2447		The right term of the modified equation = the left term OK
T_{gm} =	302.4	lb/ft		Tension of the uplifted geomembrane, $T_{gm} = J*\varepsilon$
u =	1.25	ft		Uplift height of geomembrane
θ =	14.16	deg		Angle between gmb. and supporting soil, $\theta = \sin^{-1}(P*L/(2*T_{gm}))$

Design anchorage spacing for slopes Below Bench #3		
	@	**14.00 ft on center in one direction**
	@	**14.50 ft on center in the orthogonal direction**