Keystone Sanitary Landfill
Phase III

MAJOR PERMIT MODIFICATION

Application Review

for
THROOP BOROUGH
DUNMORE BOROUGH

February 2015

Prepared by:

Martin and Martin, Incorporated
37 South Main Street, Suite A
Chambersburg, PA 17201
Phone: 717.264.6759
Fax: 717.264.7339
Website: martinandmartininc.com
with:
Meiser & Earl, Incorporated - Hydrogeologists

Keystone Sanitary Landfill – Phase III
LANDFILL MAJOR PERMIT MODIFICATION
Application Review

TABLE OF CONTENTS

Keystone Sanitary Landfill – Phase III
LANDFILL MAJOR PERMIT MODIFICATION
Application Review

General Review

Introduction

Martin and Martin, Inc. (M&M) was retained by the Boroughs of Throop and Dunmore to perform an independent review of elements of the Phase III Major Permit Modification – Phase III Site Development application of Keystone Sanitary Landfill (KSL). Within the context of Pennsylvania's Waste Management Rules and Regulations, M&M completed a general review of the Application Binders and Design Plans, including an on-site tour to view the physical elements of the site. In addition to our general review of the submittals, among the specific elements of the Application which were reviewed in greater detail are:

Storm Water Management - Form I

Hydrogeology – Form 7

Mining – Form 11, Form 24

Gas Management and Odor Control – Forms 24, G (B) and K

Radiation Protection – Form X

Nuisance Minimization Control Plan – Form 24

Background

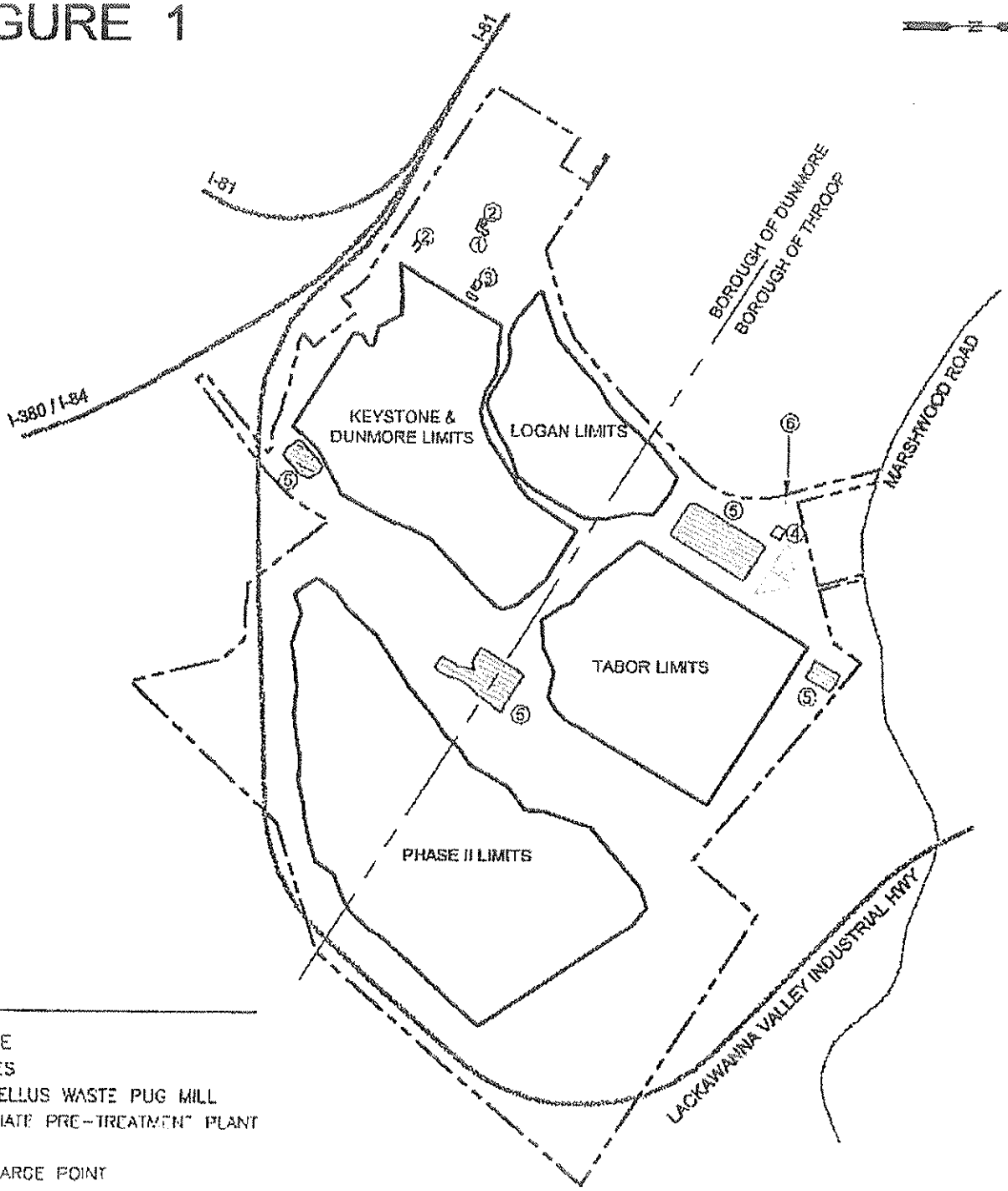
Keystone Sanitary Landfill, located in the Boroughs of Throop and Dunmore in Lackawanna County, filed an Application with the Pennsylvania Department of Environmental Protection (Pa DEP) Major Modification to increase its disposal capacity

within its current permit limits. No increase in either average or maximum daily tonnage acceptance rates is proposed. Martin & Martin, Inc (M&M) was retained by the two Host Boroughs to review certain engineering aspects of the Application, which review was undertaken within the context of Pennsylvania's applicable Waste Management (Chapters 271 and 273) and Storm Water (Chapter 102) Rules and Regulations.

Keystone Sanitary Landfill is located on a 714 acre parcel, within which are four (4) areas wherein municipal solid waste has been placed; Keystone/Dunmore, Logan, Tabor, and Phase II. Of these four areas, three currently have liner systems beneath the waste. The Keystone/Dunmore disposal area is not lined, and a recently approved Pa DEP modification allowed for the exhumation and relocation onto lined areas of approximately 8.8 millions tons of the waste from the Keystone/Dunmore area. Figure 1 depicts the existing site with the currently permitted disposal areas, and Figure 2 shows the site location. On Figure 3, we've circumscribed in red the approximate footprint within which the Phase III disposal capacity and related construction is proposed.

The landfill's currently approved average disposal rate is 7,250 tons/day, with a maximum daily rate of 7,500 tons/day, and the site operates 306 days/year. The remaining permitted capacity and longevity of the site as of December 2013 approximates 21,000,000 tons or 9.4 years.

FIGURE 1



mmi martin and martin incorporated
phone (717) 264-6759
37 south main street • suite A
chambersburg, pennsylvania . 17201

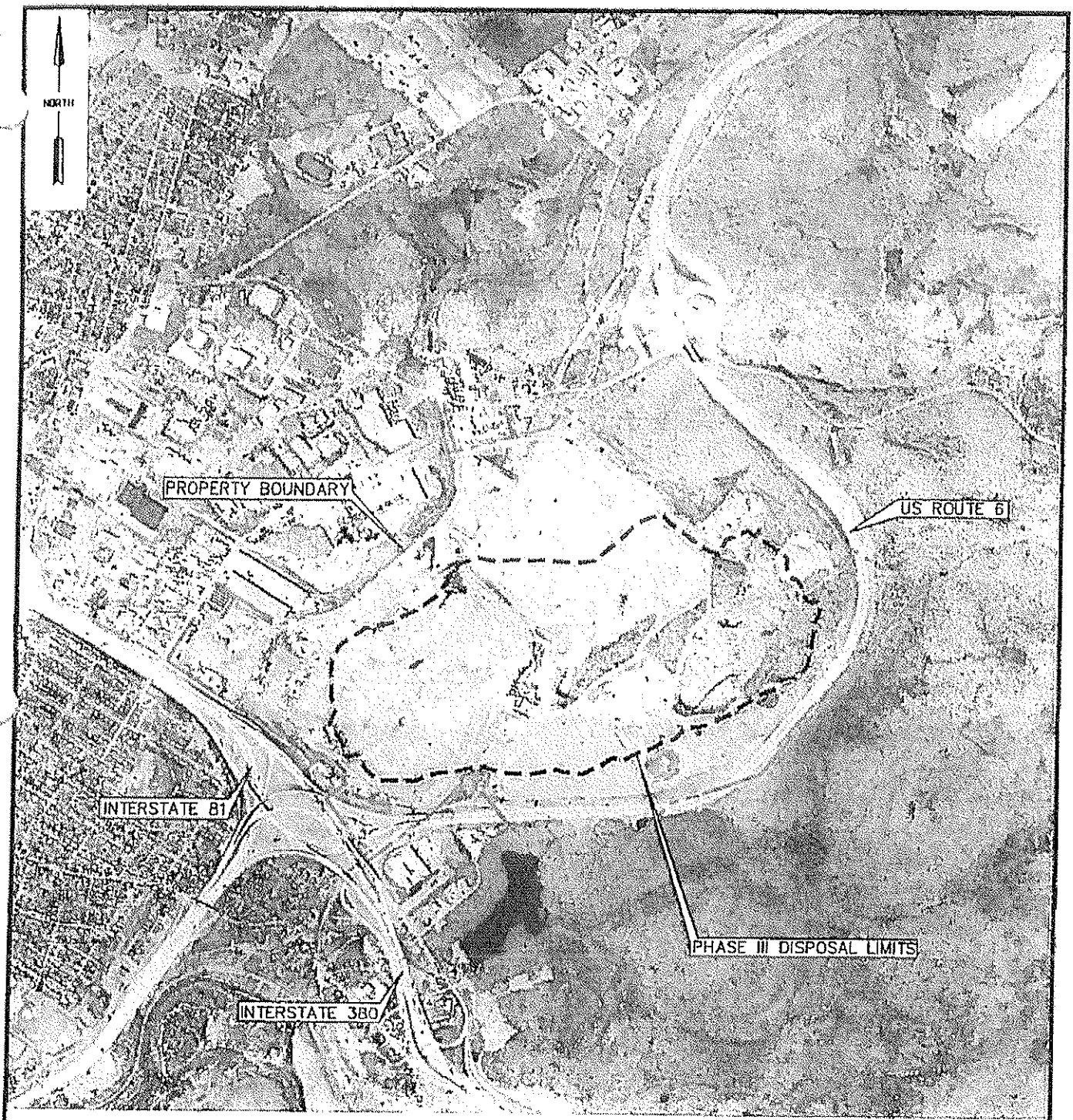
EXISTING SITE

DUNMORE BOROUGH THROOP BOROUGH

KEYSTONE SANITARY LANDFILL

PENNSYLVANIA

Scale: ---
Job # 1646
Date: 1.2016
By: MSH
Chk'd: RMB



AERIAL IMAGES ARE PANELS 47002550PAN, 47002560PAN, 48002550PAN, 48002560PAN DOWNLOADED FROM PASDA.COM (PENNSYLVANIA SPATIAL DATA ACCESS WEBSITE).

SCALE
2000 1000 0 2000
SCALE 1" =2000'

BAI GROUP INC.
Balanced Environmental Solutions

KEYSTONE SANITARY LANDFILL, INC.

PROPOSED PHASE III LANDFILL EXPANSION

DUNMORE BOROUGH/ THROOP BOROUGH | LACKAWANNA COUNTY | PENNSYLVANIA

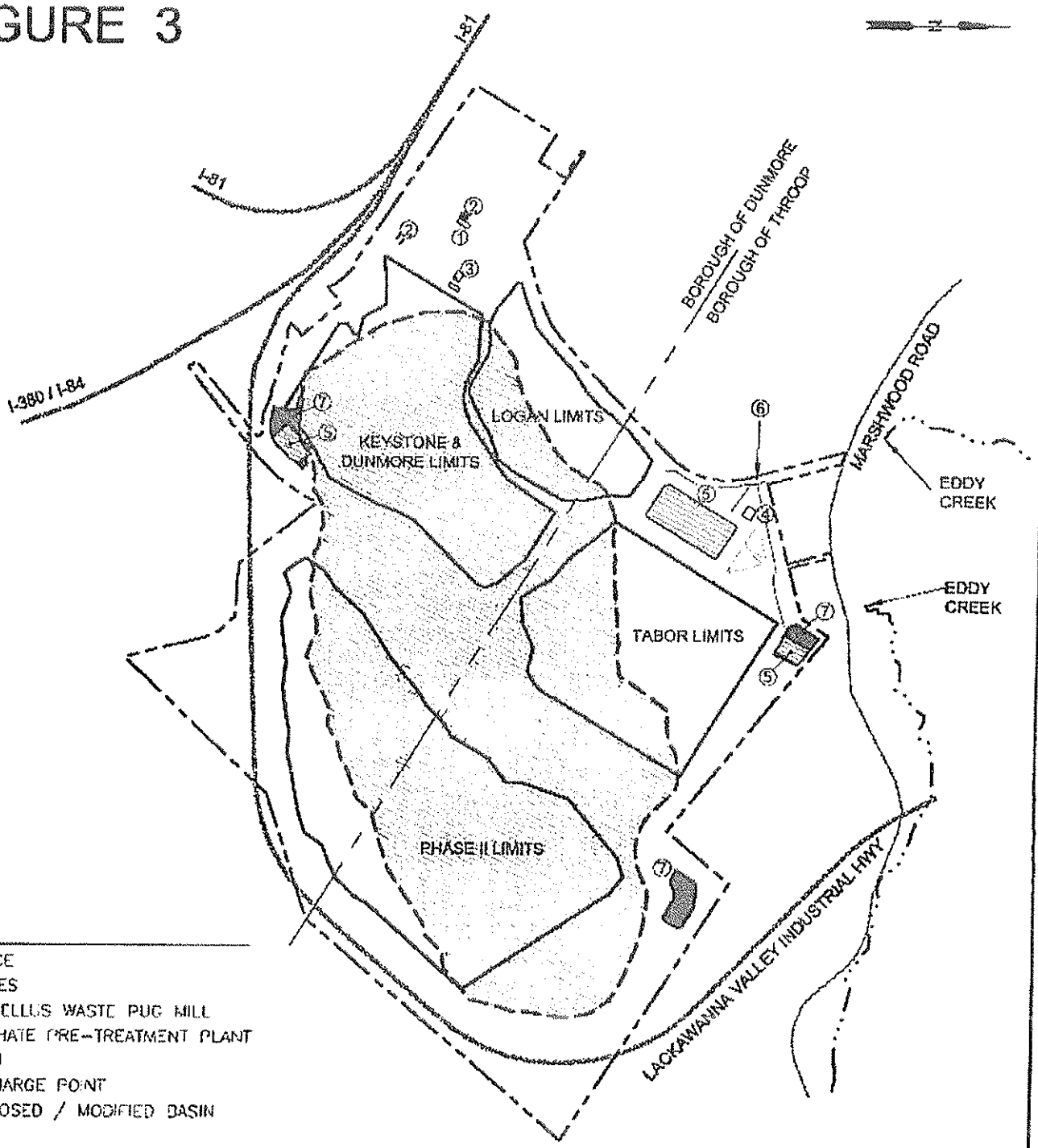
SITE LOCATION MAP

DATE:	
03/11/14	
DRAWN BY: JCF	CHECKED: MLR
BAI DRAWING NO: CECO-026A002	

State College Office (814) 238-2060 • Delaware Valley Office (610) 486-5585 • Delaware Office (302) 449-4961

FIGURE 2

FIGURE 3



martin and martin incorporated
phone: (717) 264-6759
37 south main street • suite A
chambersburg, pennsylvania . 17201

SITE PLAN

DUNMORE BOROUGH THROOP BOROUGH
KEYSTONE SANITARY LANDFILL
PENNSYLVANIA

Scale:
Job # 1546
Date: 1.2015
By: MSH
Chk'd: RMB

B:\DRWG\1546\GIS\MAPS\SITES-02.DWG, LL 2/6/2015 12:11:10 PM

In 2012, the types and quantities of wastes accepted included:

2012 Wastes Accepted

type	tonnage	% of total
Municipal Solid Waste	1,030,000	77
Drill Cuttings	129,000	10
Flood Wastes	70,000	5
Sludge	41,000	3
Residuals, C&D, Asbestos, Ash	68,000	5
Total	-	**1,338,000 tons/year (2012)**

The landfill can accept up to 2,218,500 tons/year.

No changes in the approximate waste acceptance mix are proposed.

Proposed Modification

As noted above, the Major Modification does not propose any increase in either waste acceptance rates or any increase in permit footprint. The requested change is to essentially connect the 4 existing disposal footprints, together with currently unfilled areas located between those areas, to result in one large lined landfill footprint, as shown on Figure 3. The regraded Keystone/Dunmore area will have clean earthen fill placed atop the remaining old waste prior to the installation of a new liner system both thereon, and on the remaining unfilled areas within the Modification limits, creating a continuous liner system on the entire site disposal footprint.

The approximate additional capacity proposed totals 142,961,948 cubic yards or 105,791,842 tons; adding approximately 48 years of life to the site.

Summary of Findings

A. GENERAL APPLICATION SUBMITTAL - Following our review of the Application, we believe that the submittal and designs appear to be generally complete and consistent with Pennsylvania's applicable Rules and Regulations, and with industry standards.

B. PROPOSED FIL HEIGHT – Although there are no specific Pa DEP Regulations relative to landfill height limitations (other that geometry constraints), the Department has historically imposed height restrictions on some landfills based on visual impacts mitigation, and Pa DEP should determine whether such limitations are appropriate for this modification.

C. STORM WATER MANAGEMENT – While we believe that the storm water management design is generally consistent with Pa DEP applicable regulations and requirements, we have specific engineering questions and/or comments relative thereto that Pa DEP and the KSL should consider and address as deemed appropriate.

D. HYDROGEOLOGY & DEEP MINE ANALYSIS – Pa DEP and KSL should confirm that the liner system maintains the requisite separation above the water table. They should also ascertain that the Application adequately presents the required liner system integrity demonstrations above the mined areas.

E. RADIATION PROTECTION – KSL's Radiation Protection Plan is consistent with Pa DEP requirements. Pa DEP is actively evaluating safe disposal protocols for wastes containing TENORMS (such as shale drilling

wastes). The Boroughs should encourage Pa DEP to continue the review of these protocols, and to keep the Boroughs appraised of any recommendations that evolve.

F. **GENERAL OPERATIONS – The KSL Plan of Operation, Gas Management System and Procedures, Nuisance Minimization, and related daily operational procedures remain generally unchanged from currently approved practices and are consistent with Regulations and industry standards.**

The following sections, present some more specific observations, comments, suggestions, recommendations, and questions we suggest the Permit Applicant and PaDEP consider during the Application review process. Elements of the proposal discussed in the following sections include:

1. Fill height and visual impacts
2. Storm water management
3. Hydrogeology - design basis and Deep mine analysis
4. Radiation protection
5. General Operations, including Gas Management and odor control and Nuisance minimization

Fill Height and Visual Impacts

Discussion

The Phase III Modification incorporates the placement of additional waste atop portions of the existing four disposal areas of Keystone Sanitary Landfill, as well as in currently unfilled areas which lie within those four areas, generally as shown on Figure 3. The design fill contouring is consistent with PaDEP's regulations and essentially creates a pyramid with 33% slopes (3 horizontal to 1 vertical), with drainage terraces at regular vertical intervals. There are no regulatory height limitations, thus the geometry of these maximum allowable slopes dictate the maximum height that the landfill footprint can attain.

In the case of the Keystone Phase III proposal, the slope constraints result in an approximate maximum elevation of 1750 feet above sea level. The current maximum permitted elevation of the site is 1585 feet, and the current (2013) maximum fill elevation that the landfill has attained is about elevation 1525. Thus, there is about 60 feet of additional approved height per the current permit yet to be placed, and an additional 160 feet over that per the Modification Application.

With respect to the depths of waste proposed over the liner grades, Figure 4 shows the range of waste depths by isopach increments, with the red, orange and flesh colored areas being the thickest. The maximum thickness of waste approximates 500 feet. The additional thickness of waste (over either the unfilled areas or the permitted final grades in the four waste footprints) is shown on Figure 5. The maximum additional thickness of

waste is about 445 feet (dark blue), which occurs by the sedimentation basin in the currently unfilled area between the Keystone/Dunmore site and the Phase II site.

The Application addresses visual impacts, includes some line of sight presentations, and notes that there are higher land features nearby. Figure 6 shows the location of the landfill, and identifies some of the higher peaks to the east of the site. As noted above, DEP does not have regulations that specifically address height limitations of landfills. The Department has historically, however, addressed landfill height impacts in its Harms-Benefits analysis, and in the past has placed restrictions on landfill heights.

FIGURE 4 - Fill Thickness over Liner Grades

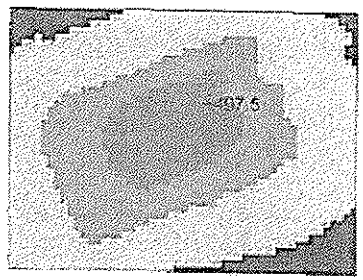


FIGURE 5 - Additional Waste Thickness above Currently Permitted Elevations

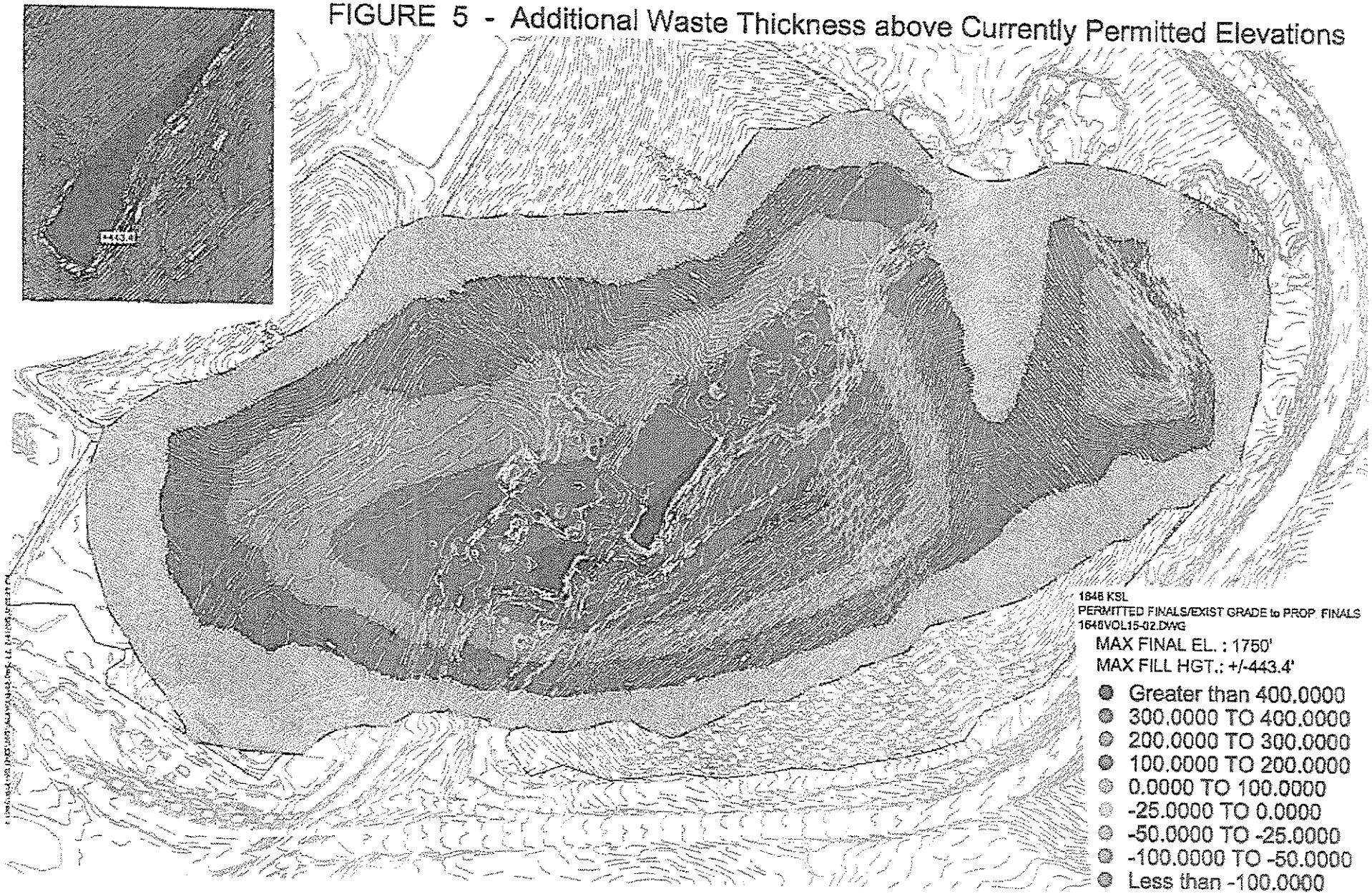
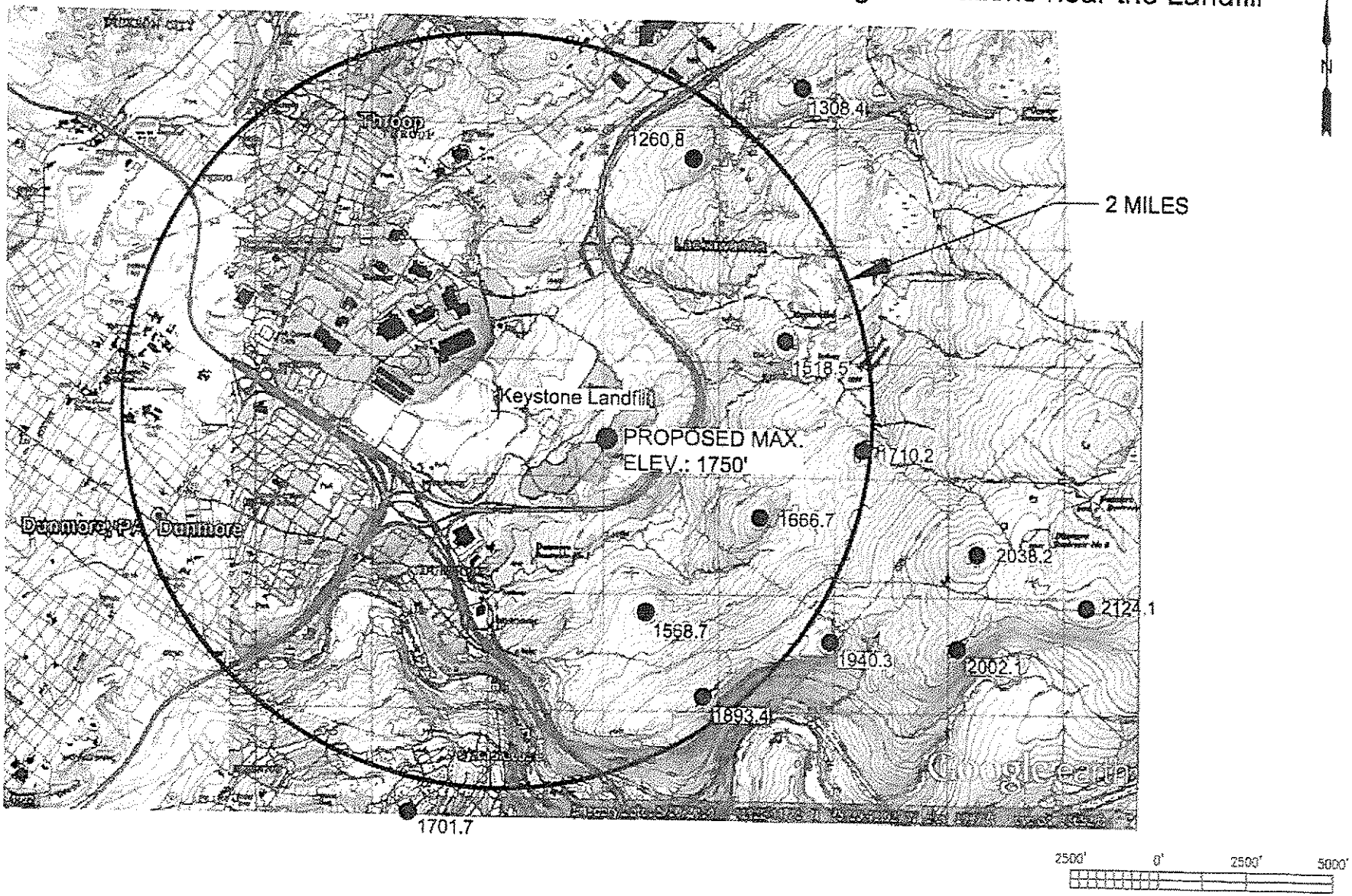


FIGURE 6 - High Elevations near the Landfill



STORM WATER MANAGEMENT

Description

The Keystone Sanitary Landfill proposes an expansion to its existing operation, encompassing a new solid waste disposal area approximately 455 acres in size. The expansion proposes to occur on existing waste disposal areas as well as areas not previously utilized for waste disposal and is termed "Site Development - Phase III" on the plans submitted. The expansion requires PADEP approval of a Major Modification to the Facility's existing Solid Waste Permit. We reviewed the Form I and accompanying plan drawings relative to the regulations contained in Title 25 Pa. Code Chapters 102, 271 and 273, and the PADEP Erosion and Sediment Pollution Control Program Manual (ESPC Manual) Technical Guidance Number 363-2134-008, March 2012.

The general concept for stormwater management on the site is common to large construction sites and represents a continuation of the methods that are currently employed. Surface runoff is collected through a series of slope benches, down drains and large channels, which convey runoff to large central sedimentation basins. In the basins, sediment settles out of stormwater and is removed for disposal, prior to the 'clean' stormwater being discharged to off-site receiving waters.

On the Keystone site, the sediment basins are situated "in series"; stormwater discharged from one basin or basins is intercepted by a subsequent basin prior to ultimate discharge from the site. While construction of basins in series is generally discouraged by PADEP - Page 159 of the ESPC Manual states: "Sediment basins may not be located within the

drainage area of a sediment trap or another sediment basin (unless the sediment basins are integral to the permanent stormwater design and are properly sized for storage and discharge capacities)". Nevertheless, the basins appear to be integral to permanent stormwater design on the Keystone site. Four sediment basins currently exist on site. They are labeled Basins 1, 3, 4 and 5 on the plans.

Associated with the pending Modification, major site modifications and stormwater management-related work will include, but may not be limited to:

(a) an enlargement of existing sediment Basins 1 and 5,

(b) construction of one new sediment basin identified as Basin 6,

(c) removal of existing Basin 3,

(d) realignment of a perimeter access road, and

(e) relocation of the existing Material Processing Facility and Raw Product Stockpile Areas.

Existing Basin 4 will remain onsite, unchanged. According to Page 5 of the Form I stormwater narrative, all of the new sediment basins, and modifications to existing basins, will be constructed prior to the placement of any waste in the Phase 3 Area. Basin 3 will remain in place until later stages of construction.

Eddy Creek

All stormwater discharged from the site is received by Eddy Creek. The design suggests that all stormwater will be discharged from Phase III at or below existing peak discharge rates for all precipitation events up to and including a 100-year storm. No increase in

peak discharges are proposed, nor does the project involve modifications to Eddy Creek, or restoration of the Creek's base flows to pre-mining conditions. As part of the Harms-Benefits analysis submitted to PADEP, the Keystone Sanitary Landfill has offered to contribute to any future project that may be undertaken by the Bureau of Abandoned Mine Reclamation (BAMR) to restore the Eddy Creek stream corridor. The likelihood or viability of such a project is unknown at this time.

While we find the basics of the Application's storm water management proposal to be generally consistent with DEP applicable regulations and requirements, we offer the following comments and suggestions:

Comments and Suggestions

Plan Drawings

1. The submittal would benefit from the addition of a legend on all plan view drawings.

2. The receiving Waters of the Commonwealth could be clearly shown all applicable plan view drawings where said Waters are within the extent of topography provided. [102.4(b)(5)(v)]

3. Additional details of the downstream flow path from the point of discharge to the confluence with Eddy Creek would be useful, as may be enlarged scale topography of the subject area.

4. The proposed topography shown on the plans appears to have been generated electronically. The finer details of the topography may not represent actual conditions that will be constructed; for example this seems evident with regard to

the proposed slope benches, about which a comment is offered in the following Channel Design section of this review.

5. Proposed contour elevations are not readily identified on many of the plan view drawings. Contour elevations could be labeled at regular intervals to facilitate ease of reference.

6. We would suggest that the project Limit of Disturbance boundary be identified on the plans encompassing all proposed earth disturbance areas associated with the project. The size, in acres, of the disturbed area(s) could be indicated as well.

7. We would suggest that the required locations and diameter(s) of all compost filter socks be specified on the plans.

8. Additional Operation and Maintenance specifications would be useful on the plans for the various erosion and stormwater controls. Specific provisions for operation, maintenance and frequency of activities would be beneficial for each facility type.

9. A construction sequence for the entire life of the landfill would similarly be beneficial.

Channel Design (Form I – Exhibit I.1)

10. Page 4 of the Exhibit I narrative states that the SCS method was utilized to calculate peak runoff and size drainage ditches and terraces, however it appears that channel designs are based on the Rational Method.

11. Benches are to be designed with a minimum longitudinal slope of 2% and a maximum slope of 5%. According to the proposed grading plan, both of these

limiting parameters appear to be exceeded. These conditions appear to be related to the aforementioned methods used to generate proposed topography. (ESPC Manual p. 157)

12. It is unclear where the peak runoff rate of 101.99 cfs was obtained for the design of down slope ditches. A calculation or a reference to the calculation in Exhibit I.1 could clarify this.

13. It is unclear which time of concentration path was analyzed for the design of down slope ditches.

14. Due to slopes exceeding 10%, should down slope ditches be designed based on the governing shear stress rather than maximum velocity? (ESPC Manual Standard Worksheet #11)

15. The designer may want to ensure that the subject channel being analyzed is indicated on all channel calculations pages in Exhibit I.1. In some cases, it is difficult to determine the channel for which calculations are provided.

16. Although page 3 of the Narrative in Exhibit I states that permanent drainage ditches were designed to safely convey the 10 year storm event, channels are to be designed with adequate capacity to convey surface runoff generated during a 25-year, 24-hour design storm per 25 Pa. Code 273.151. Contrary to the narrative statement, the calculations suggest that channels were designed based on a 25-year storm event. The narrative statement should be revised for consistency with the calculations.

17. It is suggested that perimeter channels that will convey runoff to and from sediment/detention basins be designed to convey the peak runoff anticipated during a 100-year event.

18. In some cases, it appears that conclusions and specifications contained in Exhibit I.1 are inconsistent with construction specifications on the plan drawings. A case in point is Swale/Channel 7-III. Standard Worksheet #11 in Exhibit I.1 indicates that the swale design is based on allowable velocity and that the required lining for the maximum slope condition (10%) is R-6. However, the calculated velocity seems to necessitate riprap with larger material gradation. Further, a note on the same page indicates a requirement to use smooth HDPE liner in channels with a longitudinal slope of 10% or more. As such, should the Standard Worksheet indicate a design based on shear stress and specify the appropriate HDPE liner? A subsequent "Swale Design" sheet provided in Exhibit I.1 indicates that R-8 rock lining is "OK" for Swale 7-III in the maximum slope condition of 10%. Additionally, Standard Worksheet #11 states that required channel capacity (Qr) is based on a 25-year storm event, while peak runoff calculated using Figure 5.10 (ESPC Manual p. 120) look to be based on a 10-year event. We suggest that the designer examine all calculations for consistency and clearly state the design criteria and required liner for all channels.

19. Calculations to demonstrate that benches have adequate hydraulic capacity based on the proposed topography and contributory drainage areas would be desirable.

20. All channels, existing and proposed, could be more clearly and prominently labeled on the plan.

21. Cross-section and lining information for existing channels that will remain in service for Site Development Phase III would be beneficial. Also, for calculations that refer only to existing swales in general terms – for example: "Existing Swales to Basin 1" – the subject channels could be listed to allow for reference to the channels prominently labeled on the plan.

22. Plan Sheet 65. An untitled table containing channel construction specifications includes provisions for the use of HDPE channel linings where longitudinal slope is 10% or more. The requirement for HDPE liner could be supplemented with beginning and ending channel stations, hatching the areas on the plans where HDPE is required, or by some other adequate means of specification.

23. Construction details for "Betterbilt Model #680 Earth Anchor" and its connection to the smooth HDPE liner would be beneficial, as would transverse joint details for the smooth HDPE channel lining, and for longitudinal and transverse joint extrusion welds.

24. Exhibit I.1 contains "Manta Ray" design calculations, and calculations for the "Clevenger Community Center". The purpose of these calculations is unclear.

25. It may be helpful if any necessary connection(s) between gabion energy dissipater baskets and underlying gabion baskets were specified on the plans.

26. Down drain locations should be indicated on all grading plans and drainage area maps.

Sedimentation Pond Data (Form I – Exhibit I.2)

The following Sedimentation basins will manage stormwater runoff and discharges from the site:

Basin 1: To be enlarged. Total drainage area = 147.2 acres

Basin 3: To be removed at a later date. Total drainage area not specified.

Basin 4: To remain unchanged. Total drainage area = 639.7 acres

Basin 5: To be enlarged. Total drainage area = 250 acres

Basin 6: To be constructed. Total drainage area = 105 acres

We offer the following comments regarding this Exhibit:

27. Basin 4 is downstream from, and in sequence with Basin 1. Basin 5 is downstream in sequence with Basin 6. As such, is the settling volume provided in basins 4 and 5 adequate for the total contributory drainage areas (640 acres and 250 acres, respective) directed to those structures?

28. Some of the sediment basins may fall under the regulatory authority of 25 Pa. Code Chapter 105.3.2 for jurisdictional dams. The Narrative in Exhibit I states that basins will be in conformance with the standards of the Bureau of Waterways Engineering, Dam Safety, of the Department of Environmental Protection. Have any of the Sediment Basins been deemed jurisdictional by the PADEP, and if so, are there permits for these facilities?

29. Design specifications and confirmation of the existing condition of Sediment Basin 4 has not been provided. Likewise, details have not been provided for Basin 3.

These facilities are integral to the management of sediment and peak stormwater runoff and it may be desirable if they were defined on the plans.

30. It would be desirable if adequate capacity of all Sediment Basins were confirmed for all stages of construction, including Basin 3, until the time that it is removed.

31. If the outlet structure of Basins 1 and 5 require modification, we suggest that the existing and proposed conditions of those structures be provided on the plans.

32. The anti-seep collar size listed on Worksheet #18 for Basins 4, 5 and 6 is 48 inches. It would appear that this size should be revised to 72 inches for consistency with the calculations and plan specifications.

33. The ESPC Manual recommends 1 square inch of orifice opening per each acre of contributory drainage acre for perforated risers. Unless otherwise justified, compliance with this recommendation should be confirmed for all basins.

34. The ESPC Manual p. 160 recommends a minimum surface area at the top of the sediment storage zone of Sediment Basins. Also, the Manual suggests that basins should generally have a flow length to width ratio of 2:1, unless alternative controls are provided. The recommended surface area or alternative means of compliance should be confirmed for Basins 1, 3, 4 and 6.

35. Buoyancy calculations would be desirable to demonstrate that sediment basin concrete riser bases are adequately sized.

Pipe Design (Form I – Exhibit I.2)

36. While the regulations require that pipes should be designed with adequate capacity to convey surface runoff generated during a 25-year, 24-hour design storm (25 Pa. Code 273.151),we suggest that pipes located in perimeter channels that will convey runoff to and from sediment/detention basins be designed to convey the peak runoff anticipated during a 100-year event.

37. Hydraulic calculations could not be located for Pipe P-6.

38. All outlet protection appears to be designed based on pipe discharges anticipated during a 10-year design storm. If so, it is unclear to us why the outlet protection aprons would not be designed based on the maximum condition considered in the stormwater runoff analysis, the 100-year design storm.

Basin Routing Calculations (Form I – Exhibit I.3)

39. Pre development (Operations Phase II) peak stormwater discharge rates are provided in Exhibit I.3, and a comparison is made to proposed (Phase III) peak discharge rates. The stormwater analysis concludes that Phase III discharge rates will remain at or below existing (Phase II) discharge rates. However, we could not find the calculations or supporting documents for Phase II; only a summary of the results of the Phase II analysis has been provided. Of particular relevance is the method of runoff analysis used for Phase II calculations. Also, it may be important to understand the original design parameters such as the size of contributory drainage areas to the various stormwater controls. This information would be helpful to assess the adequacy of Phase II facilities that will remain in service temporarily or permanently during Phase III.

40. Wherever contributory drainage areas to detention basins are referenced in the Exhibit I.3 narrative, it would be helpful if the entire drainage area were specified to account for upstream drainage areas when basins are in sequence.

41. Reference is made to Sheets 56 and 57 of the Site Development Plans. It is difficult to ascertain drainage patterns onto the site on the south side of SR-0006 at the I-81/I-380/SR-0006 interchange and east of same the location. Topography in this area suggests that "Drainage Area 4" may extend further e\\ast and west than currently shown. Additional detail and clarification are desirable.

42. The drainage divide shared by Area 5B and Area 6 is shifted northwest off of the waste area ridge peak and may be in need of adjustment. Likewise, the drainage divide shared by Area 1 and Area 4 appears to be shifted east to the western corner of Basin 1, whereas the actual ridge is located further to the West. Or, if this is not the case, then we suggest that the "Downslope Drainage plan" needs clarification relative to the location of the drain discharging into Basin 1.

43. Due to a diversity of topography, surface coverage, and general land slopes within Drainage Area 4, it may be appropriate for that area to be divided into two or more subareas in order to more accurately assess runoff travel times.

44. It looks as though the time of concentration (Tc) paths shown on the drainage area maps do not follow actual runoff characteristics that would be expected given existing and proposed topographic conditions. The designer should determine the Tc paths be revised in order to model actual drainage patterns over the various benches, down drains and collection channels.

45. Weighted runoff curve number (CN) calculations would be helpful for all drainage areas and surface coverage types as prescribed in the TR-55 Manual.

46. It would help if the point of interest at which existing and proposed peak discharges are analyzed were identified on the plan.

47. The grading plan seems to lack sufficient detail to show how surface runoff will be conveyed from the north slope of the new waste disposal area into Basin 4 at the South end of the Basin. Additional detail would be helpful.

48. It would be helpful if the source or sources from which manning's roughness coefficients were obtained was provided with all calculations using same.

49. A 6,500-foot reach length was utilized for Reach Hydrograph No. 5, named "Swale 4". This length appears as though it may exceed the actual flow length between Basins 1 and 4 by more than 2,000 feet. An explanation of the reach length would be helpful.

50. Each existing and proposed sediment basin is designed with a perforated riser-style outlet structure. The method used to model perforations in the risers using Hydraflow Software is difficult to confirm. A discussion of the methods used and Hydraflow output "front views" of the outlet structures is suggested to aid in the review.

51. The top-of-berm elevation of Basin 5 appears to be inconsistent between the pond Report located in Exhibit I.3, Sediment Basin Design Sheets in Exhibit I.2, and Plan Sheet 70. This apparent disparity should be addressed as needed.

Keystone Sanitary Landfill

Phase III Review

HYDROGEOLOGY AND MINING REVIEW

In the context of PaDEP's Chapter 271 & 273 Rules and Regulations relative to groundwater and mining activity at the site, we have reviewed the Form 7 and Form 11 submittals associated with the Keystone Phase III Modification. The site geology was described in the previously approved Form 6. In summary, the proposal entails the placement of waste in a +/- 455 acre footprint; including atop the three (3) previously lined Tabor, Logan, and Phase II disposal areas, atop old waste in the Keystone & Dunmore area after exhuming some of the old waste prior to installing a new liner system thereon, and in currently unfilled areas that lie between the above noted disposal areas following installation of liner systems therein. While the 3 existing lined areas do not require additional Hydrogeologic or Mining review, the other 2 areas need to be evaluated in the context of the Rules and Regulations. Forms 7 and 11 constitute the appropriate documents which were completed and submitted, characterizing the site.

The design proposes a double membrane liner system in all currently unlined areas, also with geogrid reinforcement in the Keystone/Dunmore area. Because of the historic mining beneath the site, pre-liner construction includes, where applicable:

1. Deep dynamic compaction and/or removal and replacement with compacted soils of existing landfilled materials.

2. Excavation of coal that is within 25 feet of the liner subgrade, and replacement with compacted soil.

3. Flushing with cementitious grout of any voids of 1 foot or greater that are within 70 feet of the liner subgrade.

Form 7

The Regulations require that a minimum eight (8) foot separation be maintained between the liner system and the seasonal high regional water table (273.252(b)). As a result of our review of Form 7, we suggest the following:

- A structure contour map based on the elevations on the floor of the Dunmore No. 3 would help with evaluating the Upper Aquifer System (UAS) location in relationship to the Dunmore No. 3 deep mine. The position of the mining with the liner design and the bedrock dip across the site could more easily be evaluated.
- The following are some concerns/suggestions relative to granting Keystone's requested waiver from measuring 12 consecutive months of water-level measurements (Waiver).

    1. There are 14 wells listed on Table 7-3 and on Figure 7-4 that are used to monitor the groundwater in the UAS. By comparing the calculated elevation of the floor of the Dunmore #3 mine or coal from the drill logs in Form 6 to the water-level elevations listed in Table 7-2 a determination of the position of the shallow groundwater to the floor of the Dunmore #3 can be made. It appears that only the water levels in shallow wells MW-15A and MW-28A are below the floor of the Dunmore #3. In some cases, the water levels are 18 feet above the bottom of the Dunmore #3, which seems to be contrary to the statement on page 12 of Form 7: "Any water associated with the Upper Aquifer System within Phase III limits is essentially equivalent in elevation to the floor of the Dunmore No. 3 coal seam as shown on the cross-sections." Cross Section A-A shows the proposed Phase III liner approximately 37 feet below the floor of the Dunmore No. 3. The design of the Phase III liner should be based on the UAS water-level elevations.
    2. In the Waiver request, it states that the UAS is essentially dry. This statement does not appear to be supported by the water-level elevations listed in Table 7-2 and the quarterly sampling that is performed in the 14 wells in the UAS.

3. It appears that only two wells in the UAS consistently have water levels below the floor of the Dunmore No. 3, so the statement in the Waiver that states: "The UAS monitor wells collect water in "sumps" drilled below the Dunmore No. 3 seam floor for sampling purposes," may not properly describe the conditions at the site.
4. In the Waiver, it states that the water levels in the Lower Aquifer System (LAS) show they are at considerable depths below the proposed subgrade and the existing landfilled areas. As shown on Figure 7-5 and HGS-1, the LAS water-level elevation contours show a depression around Quarry Well No. 1. It appears that pumping Quarry Well No. 1 has significantly lowered the LAS water levels.
5. The water levels listed in Table 7-2 for the wells in the UAS show a significant range in water-level elevation. These wells, however, are at the perimeter of the Phase III area and seem to provide no water-level control within the interior of the Phase III area. Consideration should be given to measuring water levels in the UAS from wells in the non-landfill portions within the Phase III area. These water levels should be measured without the pumping influence of the Quarry Well No. 1, in order to establish an 8-foot separation from the UAS and the bottom of the subbase of the liner system to meet Section 273.252(b) of the Municipal Waste Regulations.

In summary, Keystone and DEP should confirm that the proposed liner system maintains the required separation above the Upper Aquifer System.

Form 11

In addition to evaluating the existing site data relative to the modification, Keystone recently drilled approximately 56 air rotary holes in the unfilled areas within and adjacent to the proposed fill area in order to characterize the status of the deep mine workings. This drilling shows that the mines have collapsed in many areas, but voids up to 7 feet in height exist (PH3-34). According to Keystone's plan, large voids will be removed by excavation and any that remain that are 1-foot or greater in height and within 70 feet beneath the liner subgrade will be grouted. Three

different grout mixtures are proposed based on the subsurface conditions. As shown on the plan drawings, 178 holes are proposed to be drill at a minimum of 1 per acre to look for 1-foot or greater openings or unstable coal bed features that would require grouting (Form 11).
There are 14 shallow monitoring wells associated with the Dunmore #3 mine and 25 deeper wells all around the perimeter of the disposal area for quarterly monitoring. These wells have been used for to develop the Upper Aquifer System (UAS) and Lower Aquifer System (LAS) water level contour maps, respectively.

Completion of Form 11 constitutes an evaluation of the mining activity in, around and beneath the site. In essence, it is necessary to fully document the mining conditions in order to assure that the liner system remains intact. While we find that the general proposals associated with construction the new liner systems atop the mine workings are appropriate, in evaluating the information submitted, we suggest the following:

- It is unclear if the Geo-Sciences Engineering Co., Inc. Settlement Analysis Report is suggesting that the entire Keystone/Dunmore site is entirely within former strip mine activity. The entire Keystone/Dunmore site does not appear to be completely underlain by strip mining, according to Map GSE 1. It appears that deep mining beyond the strip-mine areas and under the existing waste area may exist. Thus, if DEP finds that drilling through existing waste is necessary to characterize non-strip-mine subsurface conditions in portions of Keystone/Dunmore, the "Sonic type" method of drilling could be used. (Sonic uses a high frequency vibration to drill through and sample the material it encounters without the use of compressed air). Multiple casing diameters can be used so that upper zones can be grouted or sealed from lower zones during drilling.
- Approximately 178 additional drill holes are proposed for remediation, as shown on GSE 6 and listed on GSE 7. DEP should confirm that the potential subsidence has been fully defined in the area of these holes to meet the requirements in Section 273.120 (a) (2) of the Municipal Waste Regulations?
- We could not find the listing of the drill holes that were inspected with a down-the-hole video camera and the description of the results.

- At the bottom of each cross section of the Baseline A Sections (CECO Sheets 73 through 81) a horizontal scale of 1"=20' and a vertical scale of 1"=200' is shown, but as shown by the graphical scales, the horizontal scale is 1"=30' and the vertical scale is 1"=300'.
- On Sheet GSE 7, permit condition 1 states that suspected subsidence areas will be further investigated by drilling holes to a depth to the lowest coal seam and/or a depth of 65 feet below the liner subgrade. The 65-foot drilled depth below the liner subgrade may not meet the requirement that all voids greater than 1 foot and within 70 feet of the liner subgrade will be grouted.
- Should a note in the narrative state that the P3 holes are the same as the PH3 holes?
- The equations used to calculate the results in Table 2 should be shown, as well as the numbers used in the calculations for each drill hole.
- If the final subgrade excavation encounters the collapsed zone of the former deep mine, how will this collapse material be handled before the landfill is constructed? (Hole PH3-30 is an example of this) The introduction to this section lists the three (3) conditions that would require remediation. Perhaps a collapsed zone should a fourth (4th) condition? In that vein, at what height above a broken zone within the Dunmore No. 3 mine is the subgrade excavation considered stable and thus does not require the removal of the material above the floor of the Dunmore No. 3 deep mine?

In general, DEP has determined that an application is required to provide specific estimates of potential subsidence for the area being excavated (the areas underlain by deep mining which are proposed to be lined and/or overtopped) including an evaluation of liner and landfill integrity atop deep mine workings. Keystone and DEP should ascertain that these requirements are met.

RADIATION MONITORING

Description

In accordance with DEP regulations, Keystone Landfill has been monitoring incoming waste for radioactivity since 2000, and pursuant to 273.223 of the Waste Management Rules and Regulations, has an approved Form X – Radiation Protection Plan in place. The Plan was reviewed and approved by Pennsylvania DEP. No changes to the approved Plan are proposed with the Phase III Landfill Major Permit Modification. In reviewing the site's Radiation Monitoring Plan, we do not see any elements that warrant revisions to the Plan.

In summary, all incoming vehicles must pass through the radiation monitoring system at the scales, which is set to detect radiation emissions that are more than 10 microroetgens/hour above background levels. There is a formal protocol to be followed when the monitors detect elevated radiation levels, and records are kept relative to all system alarms. In 2013, there were 131 instances where the alarm was triggered, and of these only 2 were of a nature that prohibited disposal of the material in the landfill. Approximately 70% of the 131 alarm hits were triggered by medical procedures residual Iodine 131, a short half-life radioactive tracer usually found either in discarded dressings/diapers or lingering within the body of the driver of the delivery truck. (see Attachment RM-1 2013 Radiation Reports).

Nevertheless, it is not uncommon for the public to feel uncomfortable with the concept of radiation emitting wastes being landfilled within their community. Partially in response

to public concern, which heightened with the increased gas and oil operations in Pennsylvania, with their associated waste generation, Pa DEP undertook a study in 2013, completed in 2015, relating to determination of potential environmental impact to landfill workers and the public from these wastes (Attachment RM-2). Among the results of the study is the following (RM-3):

> There is little potential for radiation exposure to workers and the public from landfills receiving waste from the Oil & Gas industry. However, filter cake from facilities treating Oil & Gas wastes are a potential radiological environmental impact if spilled, and there is also a potential long-term disposal issue, TENORM disposal protocols should be reviewed to ensure the safety of long-term disposal of waste containing TENORM.
>
> (TENORM is technologically enhanced naturally occurring radioactive materials. It is naturally occurring radioactive material whose radionuclide concentrations or potential for human exposure have been increased above levels encountered in the undisturbed natural environment by human activities)

The Host Municipalities (Throop & Dunmore) and their citizens should encourage PaDEP and the Pa Bureau of Radiation Protection to continue their review and evaluation of safe disposal protocols for wastes containing TENORM, and for those agencies to keep the Boroughs in the loop as these reviews proceed.

Radiation Report

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
1/4/2013	Orange County Transfer	Tc-99m	66.7micro	Tractor Trailer	C.Consalvo	Disposed
1/10/2013	A&D Carriers	Tc-99m	60.2micro	Tractor Trailer	C.Consalvo	Disposed
1/21/2013	CPT Transport	TI-201	606micro	Tractor Trailer	J.Biden	Disposed
1/21/2013	Breeze Transport	I-131	60.6micro	Tractor Trailer	J.Biden	Disposed
1/28/2013	JP Mascaro	I-131	31.1micro	Packer	C.Consalvo	Disposed
1/29/2013	Radiac	I-131	50.6micro	Van	C.Consalvo	Disposed
1/30/2013	Kephart Trucking	Tc-99m	141micro	Tractor Trailer	B.Reynolds	Disposed
1/31/2013	Breeze Transport	I-131	200micro	Tractor Trailer	C.Consalvo	Disposed
2/5/2013	JP Mascaro	I-131	57.0micro	Tractor Trailer	C. Consalvo	Disposed
2/5/2013	Transfer Trailer	I-131	38.2micro	Tractor Trailer	C. Consalvo	Disposed
2/7/2013	JP Mascaro	TeNorm	49.6micro	Tractor Trailer	B.Reynolds	Disposed
3/12/2013	Transfer Trailer	Ga-67	37.4micro	Tractor Trailer	C.Consalvo	Disposed

Radiation Report

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
4/11/2013	A&D Transfer	IN-111	139micro	Tractor Trailer	C.Consalvo	Disposed
4/25/2013	City of Scranton	I-131	65.3micro	Packer	J.Eiden	Disposed
4/27/2013	ANL Transport	I-131	1.57millirem	Tractor Trailer	J.Eiden	Disposed
4/29/2013	City of Scranton	I-131	76.4micro	Packer	B.Reynolds	Disposed
4/30/2013	FMH Transport	Ga-67	35.7micro	Tractor Trailer	B.Reynolds	Disposed
5/1/2013	Allservco	I-131	254micro	Tractor Trailer	C.Consalvo	Disposed
5/1/2013	Radiac	I-131	563micro	Van	B.Reynolds	Disposed
5/1/2013	JP Mascaro	I-131	79.5micro	Tractor Trailer	C.Consalvo	Disposed
5/1/2013	JP Mascaro	Tc-99m	169 micro	Tractor Trailer	B.Reynolds	Disposed
5/1/2013	JP Mascaro	I-131	48micro	Tractor Trailer	B.Reynolds	Disposed
5/2/2013	WE Trucking	Ga67	37micro	Tractor Trailer	B.Reynolds	Disposed
5/2/2013	City of Scranton	I131	77micro	Packer	B.Reynolds	Disposed
5/3/2013	JP Mascaro	I-131	57micro	Tractor Trailer	B.Reynolds	Disposed
5/7/2013	Transfer Trailer	Tc-99m	34micro	Tractor Trailer	B.Reynolds	Disposed
5/8/2013	County Waste	I-131	400micro	Packer	B.Reynolds	Disposed

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
5/10/2013	Radiac	I-131	367micro	Van	B.Reynolds	Disposed
5/14/2013	Transfer Trailer	I131	64micro	Tractor Trailer	B.Reynolds	Disposed
5/14/2013	CCI Waste	Tc-99m	32micro	Roll Off	B.Reynolds	Disposed
5/15/2013	JP Mascaro	I-131	56micro	Tractor Trailer	B.Reynolds	Disposed
5/16/2013	JP Mascaro	I-131	56micro	Tractor Trailer	B.Reynolds	Disposed
5/21/2013	Transfer Trailer	Tc-99m	36micro	Tractor Trailer	B.Reynolds	Disposed
5/21/2013	Transfer Trailer	I-131	32micro	Tractor Trailer	B.Reynolds	Disposed
5/21/2013	JP Mascaro	I131	34micro	Tractor Trailer	B.Reynolds	Disposed
5/22/2013	JP Mascaro	I131	19micro	Tractor Trailer	B.Reynolds	Disposed
5/22/2013	JP Mascaro	I131	10millirem	Tractor Trailer	B.Reynolds	Disposed
5/22/2013	Transfer Trailer	Tc-99m	41micro	Tractor Trailer	B.Reynolds	Disposed
5/23/2013	Transfer Trailer	I131	24micro	Tractor Trailer	B.Reynolds	Disposed
5/24/2013	Transfer Trailer	I131	24micro	Tractor Trailer	B.Reynolds	Disposed
5/24/2013	Action Environmental	I131	82micro	Tractor Trailer	B.Reynolds	Disposed
5/24/2013	Interstate Waste	I131	29micro	Tractor Trailer	B.Reynolds	Disposed
5/24/2013	JP Mascaro	I131	32micro	Tractor Trailer	B.Reynolds	Disposed
5/25/2013	Austin Environmental	I131	89micro	Tractor Trailer	B.Reynolds	Disposed

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
5/25/2013	JP Mascaro	I131	125micro	Tractor Trailer	B.Reynolds	Disposed
5/29/2013	Transfer Trailer	I131	302micro	Tractor Trailer	B.Reynolds	Disposed
5/30/2013	Transfer Trailer	I131	122micro	Tractor Trailer	B.Reynolds	Disposed
5/30/2013	JP Mascaro	I131	128micro	Tractor Trailer	B.Reynolds	Disposed
5/30/2013	JP Mascaro	I131	34micro	Tractor Trailer	B.Reynolds	Disposed
6/21/2013	Action Environmental	I131	25micro	Tractor Trailer	B.Reynolds	Disposed
6/21/2013	JP Mascaro	I131	22micro	Tractor Trailer	B.Reynolds	Disposed
6/27/2013	Zomerfield Hauling	I131	21micro	Rolloff	B.Reynolds	Disposed

Radiation Report

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
8/26/2013	JP Mascaro	I131	94micro	Tractor Trailer	Breynolds	Disposed
8/26/2013	JP Mascaro	I131	35micro	Tractor Trailer	Breynolds	Disposed
8/27/2013	JP Mascaro	I131	64micro	Tractor Trailer	Breynolds	Disposed
9/4/2013	Moosic DPW	I131	152micro	Packer	Breynolds	Disposed
9/13/2013	Action	Tc99m	32micro	Trailer	Breynolds	Disposed
9/17/2013	City of Scranton	I131	252micro	Packer	Breynolds	Disposed
9/17/2013	JPMascaro	I131	148micro	Trailer	Breynolds	Disposed
9/17/2013	City of Scranton	I131	252micro	Packer	Breynolds	Disposed
9/17/2013	Ellsworth Disposal	Norm suspecte	336micro	Roll-off	Breynolds	Disposed
9/17/2013	JPMascaro	I131	317micro	Packer	Breynolds	Removed
9/18/2013	Action	Tc99m	111micro	Trailer	Breynolds	Disposed
9/19/2013	Action	In-111	24micro	Trailer	Breynolds	Disposed
9/19/2013	Interstate Waste	I131	42micro	Trailer	Breynolds	Disposed
9/20/2013	Action	Tc99m	42micro	Trailer	Breynolds	Disposed
9/23/2013	Interstate Waste	I131	583micro	Trailer	Breynolds	Disposed

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
7/17/2013	Interstate Waste	Tc-99m	44micro	Tractor Trailer	B.Reynolds	Disposed
7/18/2013	Action Environmental	Ga-67	45micro	Tractor Trailer	B.Reynolds	Disposed
7/23/2013	JPMascaro	I-131	623micro	Tractor Trailer	B.Reynolds	Disposed
7/23/2013	Radiac	I131	430micro	Tractor Trailer	B.Reynolds	Disposed
7/25/2013	Interstate Waste	I131	26micro	Tractor Trailer	B.Reynolds	Disposed
7/25/2013	H&D Waste Service	I131	264micro	Packer	B.Reynolds	Disposed
7/30/2013	United Sanitation	I131	81micro	Packer	B.Reynolds	Disposed
8/14/2013	Dallas Area MA	Tc-99m	77micro	Packer	Breynolds	Disposed
8/19/2013	Radiac	I131	941micro	Van	Breynolds	Disposed
8/19/2013	Interstate Waste	I131	96micro	Tractor Trailer	Breynolds	Disposed
8/20/2013	Interstate Waste	I131	63micro	Tractor Trailer	Breynolds	Disposed
8/29/2013	Dallas Area MA	I131	74micro	Packer	Breynolds	Disposed

Radiation Report

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
10/1/2013	JP Mascaro	I131	42micro	Trailer	Breynolds	Disposed
10/1/2013	Scranton DPW	I131	31micro	Packer	Breynolds	Disposed
10/2/2013	Interstate Waste	I131	46micro	Trailer	Breynolds	Disposed
10/7/2013	Interstate Waste	In111	83micro	Trailer	Breynolds	Disposed
10/8/2013	JPMascaro	In111	25micro	Trailer	Breynolds	Disposed
10/8/2013	Action	Ga67	83micro	Trailer	Breynolds	Disposed
10/8/2013	JPMAscaro	I131	156micro	Trailer	Breynolds	Disposed
10/8/2013	Radiac	I131	26micro	Van	Breynolds	Disposed
10/8/2013	JPMascaro	In111	64micro	Trailer	Breynolds	Disposed
10/8/2013	Transfer Trailer	I131	1.13millirem	Trailer	Breynolds	Disposed
10/9/2013	Transfer Trailer	I131	47micro	Trailer	Breynolds	Disposed
10/9/2013	JPMascaro	I131	37micro	Trailer	Breynolds	Disposed
10/11/2013	JPMascaro	Tc99m	43micro	Trailer	Breynolds	Disposed
10/15/2013	Transfer Trailer	I131	284micro	Trailer	Breynolds	Disposed
10/15/2013	JPMascaro	I131	208micro	Trailer	Breynolds	Disposed

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
10/15/2013	Transfer Trailer	Tl201	231micro	Trailer	Breynolds	Disposed
10/17/2013	JPMascaro	I131	59micro	Trailer	Breynolds	Disposed
10/17/2013	JPMascaro	I131	39micro	Trailer	Breynolds	Disposed
10/18/2013	Transfer Trailer	Tc99m	203micro	Trailer	Breynolds'	Disposed
10/22/2013	Carl Horton	Norm Ra226	39micro	Trailer	Breynolds	Removed
10/24/2013	Transfer Trailer	I131	32micro	Trailer	Breynolds	Disposed
10/31/2013	Action	Ga67	37micro	Trailer	Breynolds	Disposed
11/1/2013	JPMascaro	I131	152micro	Trailer	Breynolds	Disposed
11/4/2013	Transfer Trailer	Ga67	23micro	Trailer	Breynolds	Disposed
11/7/2013	Tully Environmental	I131	64micro	Trailer	Breynolds	Disposed
11/8/2013	JPMascaro	I131	78micro	Trailer	Breynolds	Disposed
11/8/2013	JPMascaro	I131	23micro	Trailer	Breynolds	Disposed
11/9/2013	Interstate Waste	I131	167micro	Trailer	Breynolds	Disposed
11/12/2013	JPMascaro	I131	72micro	Trailer	Breynolds	Disposed
11/12/2013	JPMascaro	I131	2.39millirem	Trailer	Breynolds	Disposed
11/14/2013	JPMascaro	In111	607micro	Trailer	Breynolds	Disposed
11/15/2013	JPMascaro	Ga67	25micro	Trailer	Breynolds	Disposed

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
11/19/2013	North Atlantic	I131	49micro	Trailer	Breynolds	Disposed
11/19/2013	Interstate Waste	Tc99m	54micro	Trailer	Breynolds	Disposed
11/19/2013	Denaples Sanitation	I131	48micro	Packer	Breynolds	Disposed
11/19/2013	Action Environmental	Ga67	85micro	Trailer	Breynolds	Disposed
11/19/2013	JPMascaro	I131	165micro	Packer	Breynolds	Disposed
11/20/2013	Interstate Waste	Ga67	56micro	Trailer	Breynolds	Disposed
11/20/2013	Tully Environmental	I131	1.06millirem	Trailer	Breynolds	Disposed
11/20/2013	JPMascaro	I131	162micro	Trailer	Breynolds	Disposed
11/21/2013	JPMascaro	I131	21micro	Trailer	Breynolds	Disposed
11/21/2013	Transfer Trailer	Tc99m	46micro	Trailer	Breynolds	Disposed
11/22/2013	JPMascaro	I131	42micro	Trailer	Breynolds	Disposed
11/22/2013	JPMascaro	I131	65micro	Trailer	Breynolds	Disposed
11/26/2013	Action Environmental	I131	111micro	Trailer	Breynolds	Disposed
11/26/2013	CCI Waste	Tc99m	324micro	RollOff	Breynolds	Disposed
12/6/2013	Action Environmental	Tc99m	93micro	Trailer	Breynolds	Disposed
12/9/2013	JPMascaro	I131	74micro	Trailer	Breynolds	Disposed
12/11/2013	JPMascaro	I131	78micro	Trailer	Breynolds	Disposed

Date	Company Name	Radiation	Highest reading	Type of vehicle	Surveyor	Disposition
12/12/2013	Interstate Waste	MN-54	147micro	Trailer	Breynolds	Rejected
12/16/2013	Voyager Trucking	I131	29micro	Trailer	Breynolds	Disposed
12/17/2013	JPMascaro	I131	24micro	Trailer	Breynolds	Disposed
12/31/2013	JPMascaro	Ga-67	28micro	Trailer	Breynolds	Disposed

TECHNOLOGICALLY ENHANCED NATURALLY OCCURRING RADIOACTIVE MATERIALS (TENORM) STUDY REPORT

Rev. 0

January 2015

Prepared for:

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania Department of Environmental Protection
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17101

Prepared by:

Perma-Fix®
environmental services
A Nuclear Services and Waste Management Company

Perma-Fix Environmental Services, Inc.
325 Beaver Street, Suite 3
Beaver, PA 15009

0.0 SYNOPSIS

In 2013, the Pennsylvania Department of Environmental Protection (DEP) initiated a study to collect data relating to technologically enhanced naturally occurring radioactive material (TENORM) associated with oil and gas (O&G) operations in Pennsylvania. This study included the assessment of potential worker and public radiation exposure, TENORM disposal, and other possible environmental impacts. The study encompassed radiological surveys at well sites, wastewater treatment plants, landfills, gas distribution and end use, and O&G brine-treated roads. The media sampled included solids, liquids, natural gas, ambient air, and surface radioactivity.

The observations and recommendations for future actions based on this peer-reviewed study are:

1. There is little potential for additional radon exposure to the public due to the use of natural gas extracted from geologic formations located in Pennsylvania.

2. There is little or limited potential for radiation exposure to workers and the public from the development, completion, production, transmission, processing, storage, and end use of natural gas. There are, however, potential radiological environmental impacts from O&G fluids if spilled. Radium should be added to the Pennsylvania spill protocol to ensure cleanups are adequately characterized. There are also site-specific circumstances and situations where the use of personal protective equipment by workers or other controls should be evaluated.

3. There is little potential for radiation exposure to workers and the public at facilities that treat O&G wastes. However, there are potential radiological environmental impacts that should be studied at all facilities in Pennsylvania that treat O&G wastes to determine if any areas require remediation. If elevated radiological impacts are found, the development of radiological discharge limitations and spill policies should be considered.

4. There is little potential for radiation exposure to workers and the public from landfills receiving waste from the O&G industry. However, filter cake from facilities treating O&G wastes are a potential radiological environmental impact if spilled, and there is also a potential long-term disposal issue. TENORM disposal protocols should be reviewed to ensure the safety of long-term disposal of waste containing TENORM.

5. While limited potential was found for radiation exposure to recreationists using roads treated with brine from conventional natural gas wells, further study of radiological environmental impacts from the use of brine from the O&G industry for dust suppression and road stabilization should be conducted.

General Operations – Gas Management, Odor Control and Nuisance Minimization

In addition to the technical design elements of the landfill, including such aspects as establishing the base grades; and designing the liner system, leachate collection and management, landfill geometry, dust and gas management, and storm water management; the Application includes the methods and procedures to be followed in the daily operation of the site. Included in this category of the submittal are the Operation Plan (including the Nuisance Minimization and Control Plan), the Water Quality and Gas Monitoring Plans, Contingency Plan for Emergency Procedures. Lastly the Application presents the site closure and post-closure plan, including the bonding of those activities.

As noted previously, while the design elements associated with the Modification are specific to the Phase III proposal, essentially all of the operational aspects of the site have been previously reviewed and approved by Pa DEP, and will remain in effect relative to the extended life of the landfill.

The bonding presentation has been revised to reflect the increased size of the disposal footprint. While the revised bonding worksheets appear to be reasonable, we would suggest that the cost presented on Worksheet I – Leachate Management ($39,694,155) is not reflected on Worksheet L – Summary Cost Worksheet, line 9 ($14,157,692). This discrepancy should be addressed, and may result in a revision to the proposed amount of the bond required to secure closure and post-closure of the landfill.

A cursory review of the operational aspects of the Application, coupled with the site's more recent general reported compliance performance suggests that site's

operations are appropriate and consistent with its approved procedures and with applicable regulations.

The apparent leachate management bonding discrepancy should be reconciled.