

I-95 Landfill Reuse Study

Introduction

The County of Fairfax, Division of Solid Waste Disposal and Resource Recovery owns and operates the I-95 Landfill (site) in Lorton, Virginia. The landfill has both ash monofill and Municipal Solid Waste (MSW) disposal cells. The monofill cells support the operation of the Energy/Resource Recovery Facility that is co-located at the site. Pursuant to the original agreements on the Solid Waste Facility, the County requires an evaluation of short and long-term potential reuse alternatives for the Landfill complex. Objectives include developing an understanding of site constraints and physical limitations that lead to the initial screening and evaluation of reuse options that could potentially incorporate revenue-generating opportunities with sustainable design solutions such as renewable energy. This study is an initial step in meeting the County's commitments of the original facility charter. Any potential reuse alternatives must provide for the on-going and safe operation of the existing Resource Recovery Facility, as well as access roads and entrance facilities. Existing off-site open space and recreation facilities that are located within the immediate proximity of the site must be included in the evaluation process.

1. Kickoff Meeting and Data Gathering

CDM attended a kickoff meeting with County of Fairfax, Division of Solid Waste Disposal and Resource Recovery staff to review the scope and goals for the I-95 Landfill Reuse Feasibility Study and Analysis. The primary goal identified by the County was to analyze the reuse potential over the intermediate term (30 years) with the understanding that ongoing energy resource recovery activities from both the waste to energy facility and landfill gas recovery facility could be impacted by any proposed use. Although it was understood that long term goals could include future recreation use, at this time the County preferred to minimize public access to the site and focus on revenue generating opportunities with potential private entities.

The following data and documentation was provided by the County and reviewed by CDM:

- Evolution of the I-95 Landfill Resource Recovery, Land Reclamation, and Recreation Complex, August, 1983 (The Gray Book).
- I-95 Landfill Resource Recovery, Land Reclamation, and Recreation Complex: Historical Perspective and Description of a Regional Facility, March, 1997 (The Silver Book).
- Northern Virginia Regional Park Authority Master Plan.
- Fairfax County Park Authority Master Plan (Laurel Hill Park).
- Sanitary Landfill Closure Drawings and Specifications.
- Sanitary Landfill 2008 Survey.
- Sanitary Landfill Gas Collection System.
- Delineation of limits of Clay and Synthetic liner.
- Aerial Photograph.

- I-95 CDD Potential Landfill Expansion Scenarios 1-3.

2. Site Visit and Visual Impacts Analysis

CDM conducted a site visit including an inventory of adjacent land use and a detailed analysis of existing site features and activities. In order to determine the potential impacts of landfill reuse on the surrounding community, CDM first conducted a visual impacts analysis from each of the primary adjacent land uses. Generally the limits of this analysis included Interstate 95 to the east, the Occoquan River to the west and Furnace Road to the north. Based on an additional request by the County, CDM included the residential area west of the Occoquan River, bordering Rte. 123. Figure 2.1 highlights the following:

- Identification of the adjacent land use (highlighted in yellow);
- The potential visual impact of reuse on the adjacent land use; and
- The importance of minimizing visual impacts to the adjacent land use. Residential and community uses rating high and commercial/industrial rating low.

Second, CDM conducted a detailed analysis of the I-95 complex, including access points, circulation patterns, access roadways, existing site features and ongoing site activities (Figure No. 2.1). As a result of this analysis, several areas were identified as active and therefore eliminated for reuse consideration at this time. These include the ash landfill and future expansion, the Energy Resource Recovery facility, administration areas and the recycle and maintenance areas. Each of these areas is highlighted in yellow on the adjacent maps.

The remaining area highlighted in red on Figure 2.1 consists of 225 acres of a Municipal Solid Waste (MSW) capped landfill and was considered for potential reuse opportunity. The future final elevation of the ash landfill and the adjacent private landfill are considerably higher than the area considered for potential reuse. This was taken into consideration when assigning a visual impacts rating for each of the adjacent land uses. The following section supported by Figure 3.1 through Figure 3.5 describes a site specific analysis that was conducted on the area considered for potential reuse.

3. Site Analysis

3.1 Slope Analysis

Utilizing the 2008 Existing Conditions Survey, CDM conducted a slope analysis to identify the optimal areas for potential reuse (Figure 3.1). Since the entire area under consideration for reuse consists of a capped MSW landfill, several factors were considered as follows:

1. Impacts that future modifications to the existing slopes will have on the capping system. This could include importing fill materials to increase the square feet of areas less than 5% slope,

which could result in increased potential for settlement and potential damage to the capping system,

2. Impacts that future activities on the existing slopes will have on the capping system,
3. Impacts that future modifications will have on the current drainage patterns. Reuse activities could require drainage swales and for storm water be diverted to other parts of the landfill, and
4. Potential surface cover erosion that could occur due to future modifications or activities.

The more level areas of the landfill (those with slopes less than 10%) would be more suitable for the majority of reuse opportunities. Areas where the existing slope is less than 5% would require minimal modifications provided those modifications consisted of an engineered solution that took the factors described above into consideration.

Areas where the existing slope is greater than 5% but less than 10% may require more significant engineered solutions depending on what reuse opportunity is being considered. However, for the purpose of this analysis, these areas do have potential for reuse and more significant engineered solutions are considered feasible.

Modifications and activities on slopes greater than 10% could significantly impact the daily cover; increase the potential for erosion, and the potential exposure to failure of the existing capping system.

3.2 Solar Photovoltaic Analysis

Based on the 2008 Existing Conditions Survey, CDM conducted a conceptual solar photovoltaic (PV) analysis of the site. Figure 3.2 identifies the Optimal and Secondary Solar Energy Areas. The northern portion of the Optimal Solar Energy Area should be considered temporary and its value based on the Ash Landfill expansion schedule. In general, the optimal site area was selected based on a south orientation and slopes in the 5-10 percent range.

For a fixed mount solar system, panels are ideally mounted south facing at an angle equal to the site's latitude, which for Lorton, VA is 39 degrees from the horizontal. Based on this site's capped topography, significant surface modifications, including cap penetrations, would be required to establish slopes that would achieve a 39 degree angle. Therefore, achieving a 39 degree angle is not considered feasible. A ballasted (non-penetrative) type PV mounting system is recommended for the Optimal Solar Energy Areas of the landfill. This type system would utilize concrete blocks to hold the PV mounting structure in place, thus eliminating the need for ground penetration supports. The mounting angle for these types of systems usually ranges from zero to twenty degrees, with the greater angle producing more output. The final angle would be determined based on geotechnical and structural analysis.

There are two main types of solar PV technologies – crystalline cells and thin film solar cells. Historically, crystalline cells have been more widely used and comprise over 90% percent of the total market share of solar cell technologies. Crystalline cells are convenient because stable solar cells with good efficiencies can be produced. Thin film solar cells are generally believed to have lower efficiencies than crystalline cells, but have a slightly lower installed cost per watt (W). Research suggests that thin film solar cells will be a likely competitor to crystalline solar cells in the future, as advances in efficiency and

absorption of a broader range of light are expected. Based on project solar production goals and budget, crystalline was used for this study based on the higher efficiency of this technology and estimated overall cost per watt of the panel.

The solar panel used for the analysis is a 240W panel, which is approximately 69" X 39.5" or approximately 18 square feet (sqft). This results in a power density of 13.33W/sqft. Although there are more efficient panels available, this is a mid-to-high grade panel and there are many similar modules on the market around this wattage and size, providing for price competition and availability. Based on the proposed power density and previous project design experience, for planning purposes we used the one-third approximation. This approximation assumes one third of the identified area is available for solar panels. The other two-thirds area is remaining for shading, maintenance, ancillary equipment, walkway and or roadways. Using Figure 3.2, and based on the above assumptions, design criteria, and a ten degree mounting angle, the estimated Solar PV system sizes are listed below.

Solar Energy Potential

| Site | Footprint (sq ft) | Solar Potential (kW) | Annual Production (kWh) |
|-------------------------------|-------------------|----------------------|-------------------------|
| Optimal Solar Energy | 987,086 | 4,386 | 5,248,969 |
| Optimal Solar Energy (Future) | 272,139 | 1,209 | 1,446,877 |
| Secondary Solar Area 1 | 381,923 | 1,697 | 2,030,893 |
| Secondary Solar Area 2 | 797,180 | 3,542 | 4,238,906 |

This proposed solar PV system used for this study is a utility interactive type system, meaning the output of the system will be compatible with the Energy from Waste facility and or electric utility AC power. It is assumed that no batteries will be used to store power. Further electrical interconnection coordination with the Energy from Waste and electric utility is necessary and would be completed during a more detailed study and the design phase.

For planning purposes, total turn-key pricing, including design, permitting, materials and construction for this size system will be approximately \$5 to \$5.5 per watt.

3.3 Drainage Analysis

The drainage system for the I-95 Landfill (Figure 3.3) and associated facilities consists of vegetated swales, rip rap down chutes, and several detention basins. The detention basins are primarily outside the limits of the reuse analysis area. Vegetated swales are located on the uphill side of the landfill maintenance roadways and are an integral part of the erosion control system. The optimal areas for reuse are located on the higher elevations and slopes less than 15-percent. In these areas the vegetated swales are spaced farther apart, allowing access and the space required for reuse. The vegetated swales in this area could also be modified to meet reuse needs with minimal impact to the overall closure. Modification of the vegetated swales on the steeper slopes is not recommended. Modifications to the rip rap down chutes are also not recommended.

3.4 Landfill Gas Collection Analysis

The landfill gas collection system consists of a series of vertical wells spaced across the closed MSW disposal area, with some horizontal wells located around the closure cap perimeter as shown on Figure 3.4. The gas is extracted from the wells and collected by a system of header pipes, then sent to the Landfill Gas Recovery Facility to fuel engines that produce electricity. For the purposes of this study, it is assumed that the landfill gas system will remain in operation during the majority of the interim reuse period. While the system does represent a constraint, there are system modifications that can be made to accommodate reuse alternatives. The primary concerns are protecting the operating system from damage and preventing non-landfill personnel from potential exposure. The existing riser pipes could be removed and the control valves placed in a locked vault at or below grade. The collection header pipes would require protection from puncture from any reuse alternative that requires penetration below the existing final cap system. They would also require protection from high loadings and localized settlement that could result in excessive strains or breakage. If in the future it can be demonstrated that the system is no longer required for post-closure operations, the landfill gas system may ultimately be decommissioned depending on the long-term reuse alternative(s) selected.

3.5 Settlement Analysis

CDM reviewed the final grading drawings for the Phase II Closure and compared the elevations with the 2008 survey. The results of this comparison are found in Figure 3.5. The comparison was completed on a 250-ft. grid. Sporadic areas of minor settlement in the 1-ft to 2-ft range were evident but these appeared primarily in areas outside of the Optimal Energy Areas for reuse identified from the earlier analysis. CDM also reviewed the Record Drawings for the Phase III and Phase IV Closure. In the summary meeting, County staff noted there were isolated areas of settlement northwest of the administration area. No areas of settlement were visible, based on the comparison of the Closure documents and the 2008 survey. It should be noted that the closure documents and record drawings were dated 2006 and 2009, which is not an effective basis for comparison. Settlement would be expected in these areas, and depending on the reuse, another survey or settlement monitoring program should be advanced prior to further evaluations. CDM recommends a new topographic survey in these areas and a digital comparison with the 2008 Existing Conditions Survey.

Recommended Areas for Reuse

Comparing the various site analysis figures and the optimal area from each analysis, CDM developed Figure 4.1 showing the recommended areas for reuse. Potential access points and recommended access routes are also identified. The first consists of approximately 65 acres and is at the higher elevations and more level portions of the reuse area. An access point south of the Landfill Gas Recovery Facility could be utilized, minimizing impact on the adjacent activities. This area also has a number of existing maintenance roadways that could be utilized. Since this is currently a very visible portion of the landfill, the visual impacts of any proposed reuse should be considered.

The second area consists of 20 acres and is located in the valley southwest of the former Lorton Youth Facilities. Access to this location could also be from the entrance south of the Landfill Gas Recovery Facility and the southern landfill maintenance roadway. This location has very low visibility from adjacent land uses and has the lowest impact on the County's active site activities.

A third area consists of approximately 3 acres and is located northwest of the Ash Landfill. Although it is located outside the reuse analysis area, it should be considered based on its level topography and proximity to an access point located off the Occoquan Regional Park access road.

Opportunities and Constraints

Based on the information and analysis presented above, as well as discussions with County staff, CDM developed a summary of potential landfill reuse options as shown in Figure 5.1. The options highlighted in green represent those that are currently considered feasible. The options highlighted in yellow represent those that could be considered in the future as the active operations at the site phase out. Those options highlighted in red were not considered as part of this limited study.

A list of Opportunities and Constraints were identified and are highlighted in blue along the top of Figure 5.1. Analyzing each reuse option against each opportunity/constraint, a table was developed which will assist the County in assessing the feasibility of any particular reuse option.

At this point, no specific reuse option(s) have been finalized for implementation. However, during the site analysis review workshop held with County staff, the most desirable options appear to include:

- Renewable Energy (Solar);
- Container Nursery or contract growing of plant material above the landfill cap;
- Vehicle/Boat/RV storage; and,
- Materials Storage.

Once the County has reviewed these potential options with the other landfill partners, a more detailed analysis to evaluate design issues, implementation costs, and additional stakeholder input should be performed to develop a final list of reuse options.





| LAND USE | VISUAL IMPACTS | IMPORTANCE | ASSIGNED LAND USE |
|--|----------------|------------|---|
| 1 RESIDENTIAL | LOW | HIGH | Yellow dashed line |
| 2 EQUESTRIAN CENTER | MODERATE | HIGH | Yellow dashed line |
| 3 ARTS FOUNDATION | HIGH | HIGH | Yellow dashed line |
| 4 OX ROAD | HIGH | HIGH | Yellow dashed line |
| 5 TREATMENT FACILITY | HIGH | LOW | Yellow dashed line |
| 6 OCCOQUAN REGIONAL PARK | LOW | HIGH | Yellow dashed line |
| 7 NVRPA | LOW | HIGH | Yellow dashed line |
| 8 COMMERCIAL | LOW | LOW | Yellow dashed line |
| 9 PRIVATE LANDFILL | HIGH | LOW | Yellow dashed line |
| 10 COMPOSTING FACILITY | HIGH | LOW | Yellow dashed line |
| 11 ACTIVE ASH LANDFILL | HIGH | LOW | Yellow dashed line |
| 12 ENERGY RESOURCE RECOVERY FACILITY | HIGH | LOW | Yellow dashed line |
| 13 ADMINISTRATION BUILDING FACILITY | HIGH | LOW | Yellow dashed line |
| 14 RECYCLE MAINTENANCE FACILITY | HIGH | LOW | Yellow dashed line |
| 15 LANDFILL GAS RECOVERY FACILITY | HIGH | LOW | Yellow dashed line |
| 16 FORMER LORTON YOUTH FACILITIES POTENTIAL FUTURE URBAN SEARCH AND RESCUE | HIGH | MODERATE | Pink dashed line |
| | | | Primary Access Point (Orange starburst) |
| | | | Secondary Access Gate (Green starburst) |



APPROX. SCALE: 1"=1200'

Figure No. 2.1
Land Use and Visual Impacts Analysis Plan
I-95 Landfill Reuse Feasibility Study

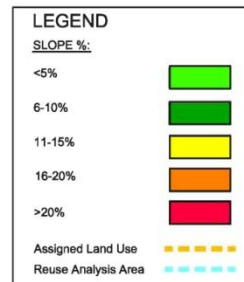
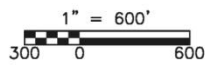
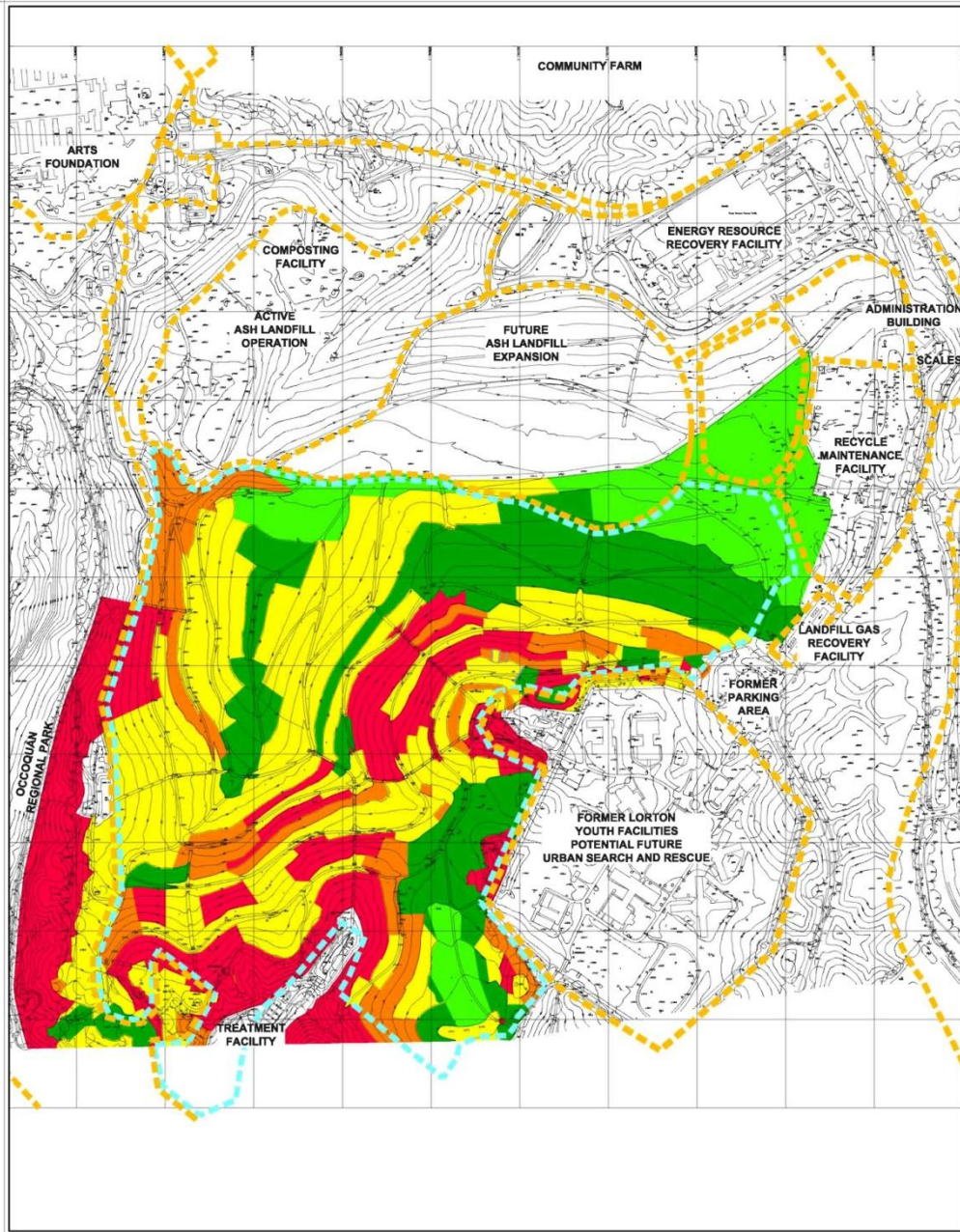
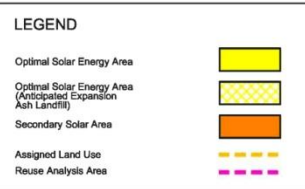
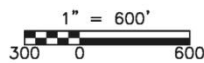
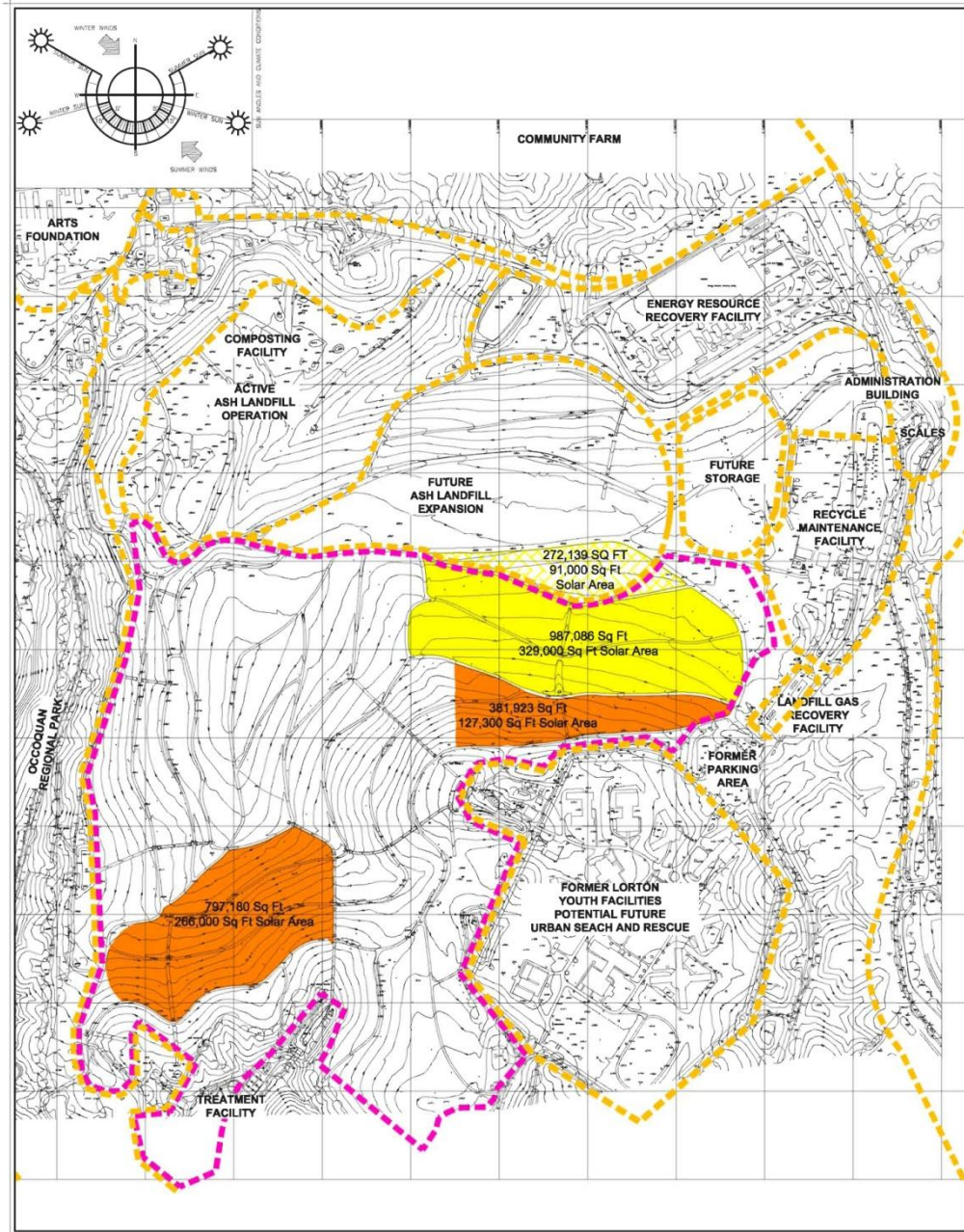
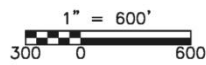
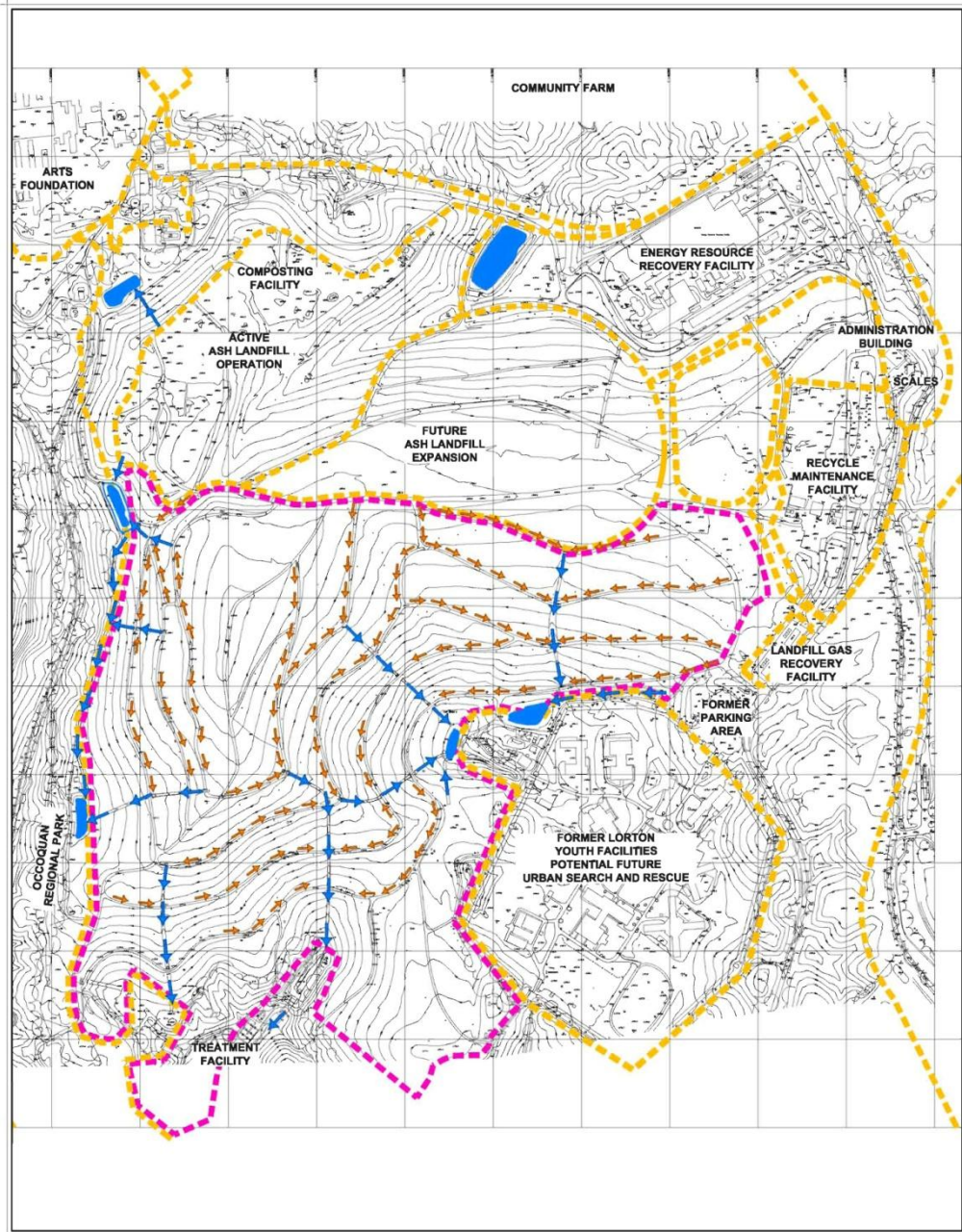


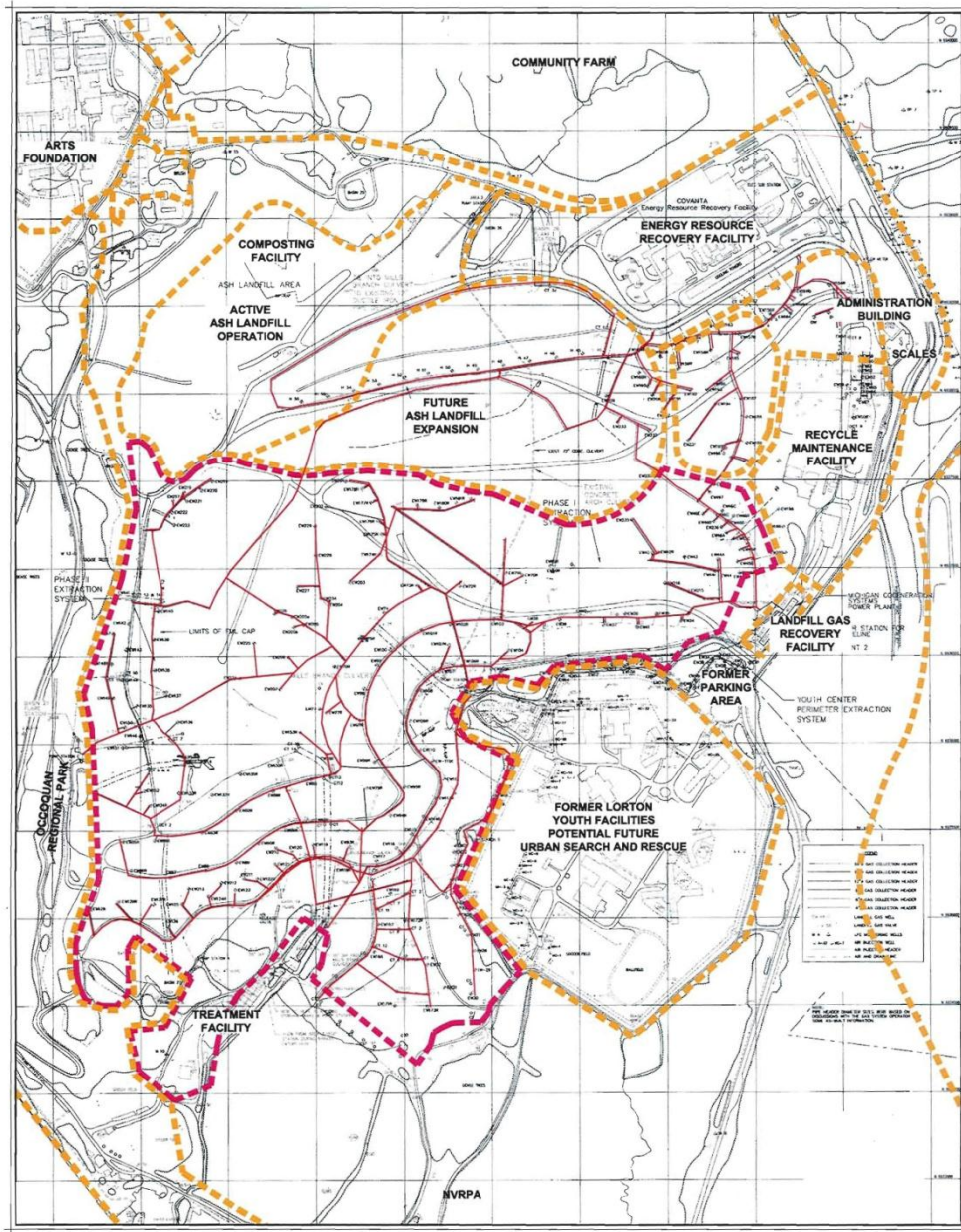
Figure No. 3.1
Slope Analysis Plan
I-95 Landfill Reuse Feasibility Study





| LEGEND | |
|---------------------|--------------------|
| Drainage: | |
| Vegetated Swale | Orange arrow |
| Rip Rap Down Chute | Blue arrow |
| Detention Basin | Blue shaded area |
| Assigned Land Use | Yellow dashed line |
| Reuse Analysis Area | Pink dashed line |

Figure No. 3.3
Drainage Analysis Plan
I-95 Landfill Reuse Feasibility Study



LEGEND

- Assigned Land Use ---
- Reuse Analysis Area ---
- Gas Collection Header —

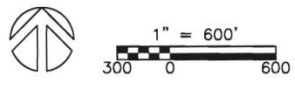
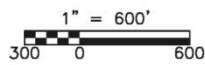
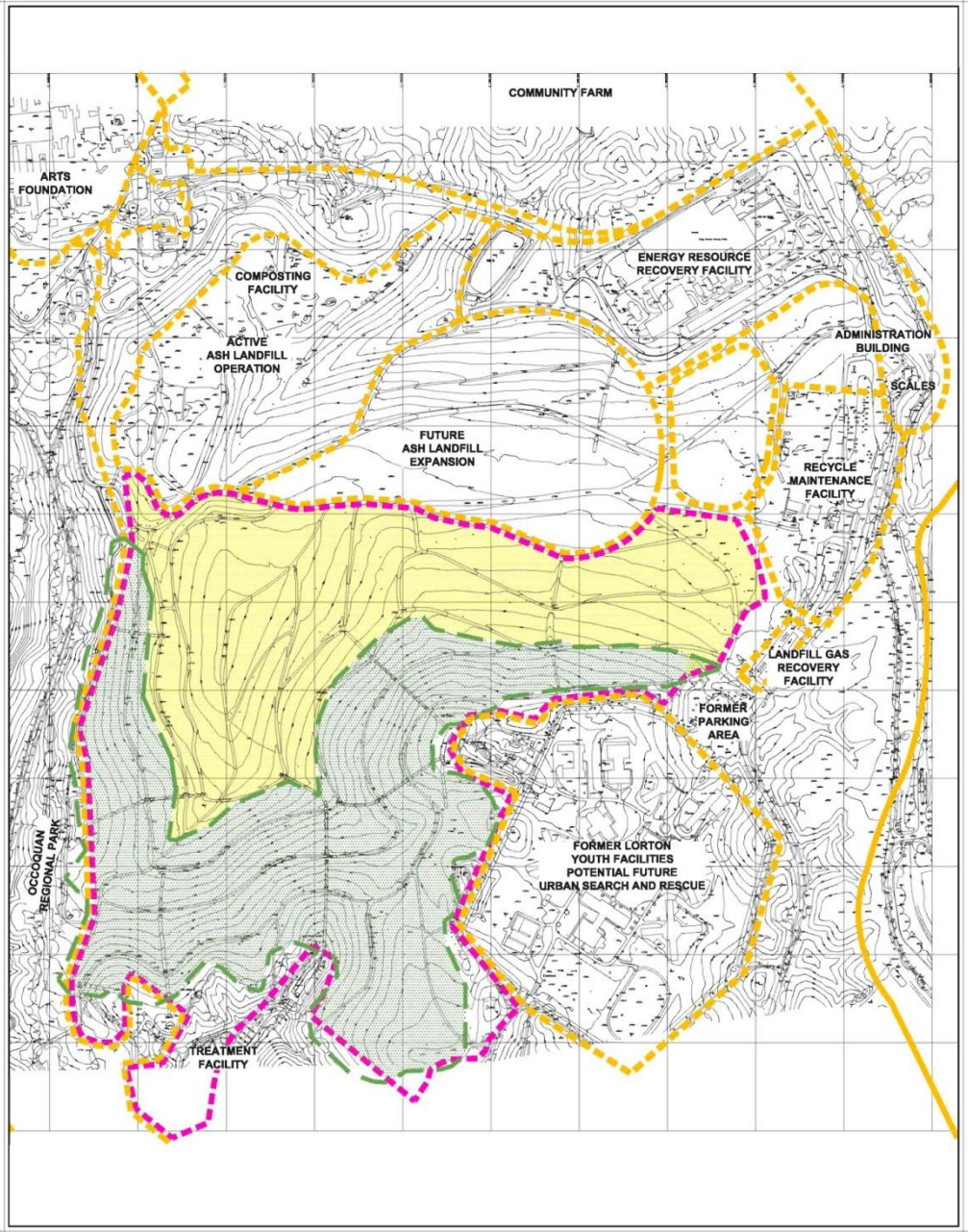
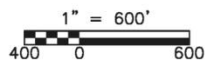
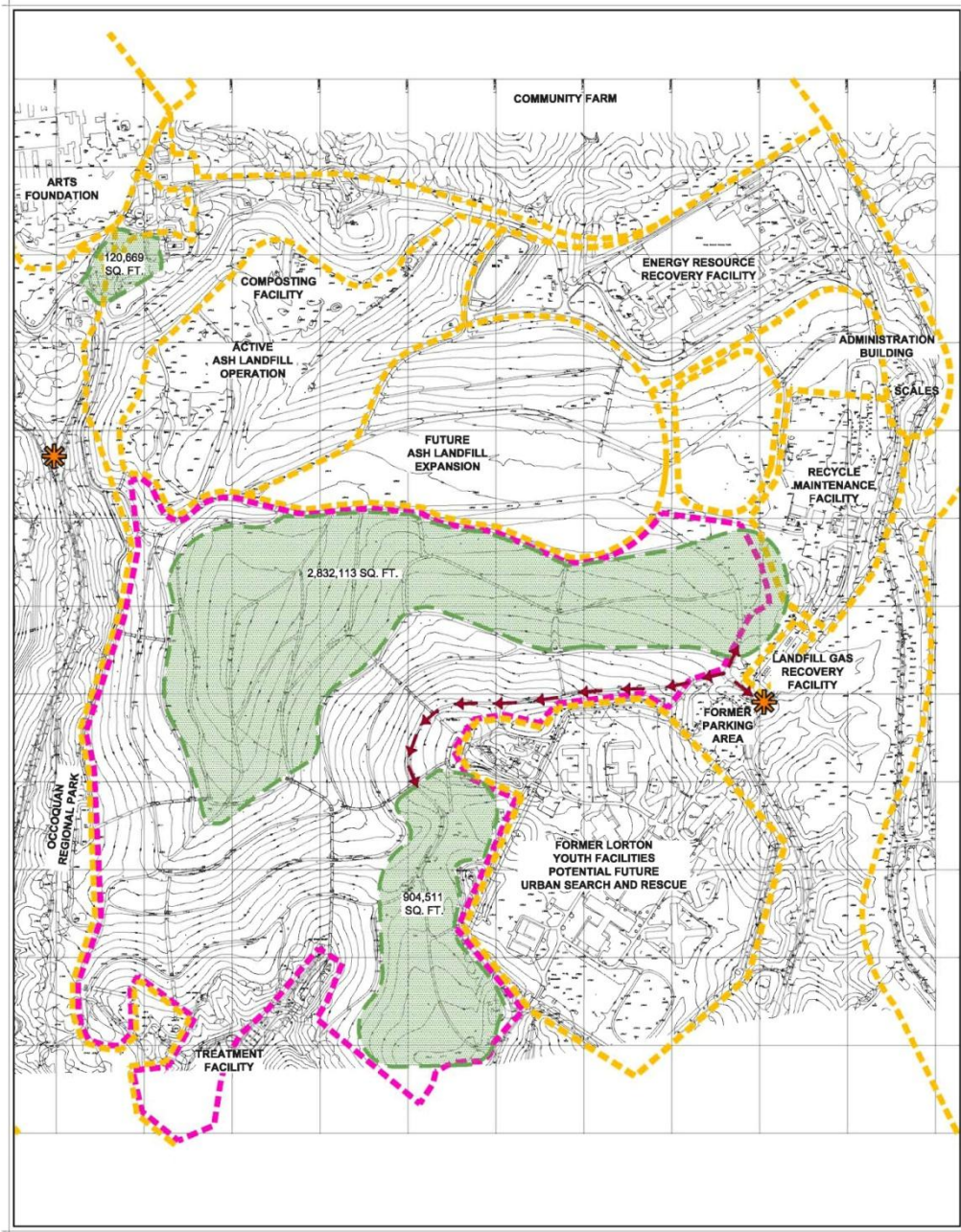


Figure No. 3.4
 Landfill Gas Collection Analysis
 I-95 Landfill Reuse Feasibility Study



| LEGEND | |
|---|---------|
| Assigned Land Use | --- -- |
| Reuse Analysis Area | - - - - |
| Area of Contour Deviation (Isolated Areas Noted) | ▨ |
| Area of No Contour Deviation (No Areas Noted) | ■ |

Figure No. 3.5
Settlement Analysis Plan
I-95 Landfill Reuse Feasibility Study



| LEGEND | |
|-------------------------|-------|
| <u>Potential Reuse:</u> | |
| Assigned Land Use | ----- |
| Reuse Analysis Area | ----- |
| Optimal Reuse Area | ----- |
| Optimal Access Points | ★ |
| Optimal Access Route | → |

Figure No. 4.1
Recommended Areas for Reuse
I-95 Landfill Reuse Feasibility Study

OPPORTUNITIES / CONSTRAINTS

| | Ash Landfill Operators | Energy Resource Recover Facility Operations | Existing Landfill Gas Collection System | Existing Landfill capping system | Potential Stormwater control features | Open Space with Slopes Greater Than 10% | Open Space with Slopes Less Than 10% | Existing Access | Compatibility with adjacent land use | Solar Aspects/sun angles | Availability of Utility/Water Service | Zoning |
|-----------------------------------|------------------------|---|---|----------------------------------|---------------------------------------|---|--------------------------------------|-----------------|--------------------------------------|--------------------------|---------------------------------------|--------|
| Reuse Options | | | | | | | | | | | | |
| • Crop Harvesting | | | C | C | C | | O | C | C | | O | O |
| • Hay/Straw for Baling | | | C | C | C | | O | O | C | | O | O |
| • Sunflowers-Biodiesel | | | C | C | C | | O | O | C | | O | O |
| • Green Houses | | | | | | | O | C | C | | O | O |
| • Wholesale Container Nursery | | | | | | | O | C | C | | | |
| Renewable Energy | | | | | | | | | | | | |
| • Solar | | O | | | | C | O | O | | | O | |
| • Wind | | O | | C | C | | C | | | | | |
| • Landfill Gas Collection | | | | | | | | | | | | |
| • Geothermal | | | | | | | | | | | | |
| • AG-Fuel | | O | C | C | C | | O | C | C | | O | O |
| Miscellaneous | | | | | | | | | | | | |
| • Vehicle/Boat/RV Storage | | | | | | | | C | | O | | |
| • Granular Materials Processing | | | C | | | | | C | C | O | | |
| • Composting Facilities | | | C | | | | | | C | | | |
| • Construction Staging | | | C | | | | | C | C | | | |
| Active Recreation (Future) | | | | | | | | | | | | |
| • Athletic Fields | C | C | C | C | C | | O | C | O | O | | O |
| • Golf Course | C | C | C | C | C | C | O | | O | O | | O |
| • Driving Range | | | C | C | C | | O | | O | O | O | O |
| • Ski Slopes | | | | | | | | | | | | |
| • Sledding Slopes | | | | | | | | | | | | |
| • Kite Flying | | | | | | | | | O | O | | |
| • Model Airplanes | | | | | | | O | | O | O | | |
| • Children's Play Areas/Equipment | | | | C | | | O | | O | O | | |
| • Skateboard Park | | | | C | | C | O | O | O | O | | |
| • Paintball | | | | | | | O | O | O | O | | |
| • BMX Facility | | | | C | C | | O | O | O | O | | |
| • Bicycle/Mountain Bike Trails | | | | C | C | O | O | O | O | O | | |
| • Skeet Shooting | | | | | | | O | O | O | O | | |
| • Target Shooting | | | | | | | O | O | O | O | | |
| Passive Recreation | | | | | | | | | | | | |
| • Amphitheater | | | | C | | C | O | O | O | O | | |
| • Equestrian Trails | | | | C | C | | O | O | O | O | | |

O OPPORTUNITIES
C CONSTRAINTS

OPPORTUNITIES / CONSTRAINTS

| | Ash Landfill Operators | Energy Resource Recover Facility Operations | Existing Landfill Gas Collection System | Existing Landfill capping system | Existing Stormwater control features | Potential Settlement | Open Space with Slopes Less Than 10% | Slopes Greater Than 10% | Open Space with Existing Access | Compatibility with adjacent land use | Solar Aspects/sun angles | Availability of Utility/Water Service | Zoning |
|--------------------------------------|------------------------|---|---|----------------------------------|--------------------------------------|----------------------|--------------------------------------|-------------------------|---------------------------------|--------------------------------------|--------------------------|---------------------------------------|--------|
| Reuse Options | | | | | | | | | | | | | |
| • Walking/Jogging Trails | | | | | | O | | O | O | O | O | | |
| • Exercise Stations | | | | | | | | O | O | O | O | | |
| • Educational/Interpretive Centers | O | O | O | O | O | O | C | O | O | O | O | | |
| • Pavilions/Picnic Areas | | | | | | O | C | O | | O | O | | |
| • Boat Launch | | | | | | | | | | | | | |
| • Dog Park | | | | | | | | | | O | O | | |
| • Summer/Day Camp | C | C | C | C | | | C | O | O | O | O | | O |
| Natural Resource/Agricultural | | | | | | | | | | | | | |
| • Habitat Restoration | | | | | | | | | | | O | | |
| • Compensatory Wetlands | | | | | | | | | | | | | |
| • Salt Marsh Restoration | | | | | | | | | | | | | |
| • Native/Ecological Restoration | | | | | | | | | | | O | | |
| • Botanical Gardens | | | | | | | | | | | O | | O |
| Office Park | | | | | | | | | | | | | |
| Industrial Park | | | | | | | | | | | | | |
| Commercial Development | | | | | | | | | | | | | |
| • Hotel | | | | | | | | | | | | | |
| • Home Depot/Target | | | | | | | | | | | | | |
| • Animal Shelter | | | | | | | | | | | | | |
| • Strip Mall | | | | | | | | | | | | | |
| • Parking Lots | | | | | | | | | | | | | |
| Residential/Housing | | | | | | | | | | | | | |
| Municipal Facilities | | | | | | | | | | | | | |
| • City/County offices | | | | | | | | | | | | | |
| • Correctional Facilities | | | | | | | | | | | | | |
| • Maintenance Facilities | | | | | | | | | | | | | |
| • Recycling facilities | | | | | | | | | | | | | |

 OPPORTUNITIES
 CONSTRAINTS