METROLINK

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A5.8 Demolition General

Contents

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LIST OF ABBREVIATIONS

ACM	Asbestos-containing material
BS	British Standard
CEMP	Construction Environmental Management Plan
EPA	Environmental Protection Agency
EU	European Union
C&D	Construction and Demolition
C& D WMP	Construction and Demolition Waste Management Plan
NEDA	Non-Explosive Demolition Agent
NFDC	National Federation of Demolition Contractors
PPE	Personal Protective Equipment
PSCP	Project Supervisor Construction Phase
TWC	Temporary Works Coordinator

1. Introduction

This appendix outlines the proposed general approach to be adopted for the demolition of private and commercial properties located along the route of the proposed Project, which currently exist in rural, urban and city type environments.

Thoughtful demolition and hazardous materials planning are crucial to preparing sites for redevelopment. Decommissioning, abatement, and demolishing are early site preparation activities that must be managed in a manner to optimise opportunities to recycle, minimise waste disposal, control surrounding environmental impacts, and to adhere to construction health and safety legislation.

It addresses the demolition requirements, sequencing, demolition methods and other requirements, e.g. pre-demolition activities and control measures, associated with demolition works on the proposed Project. It also provides estimates of quantities of demolition materials and waste that would be produced by demolition activities as part of the Enabling Works. It also identifies which buildings require a refurbishment and demolition survey for asbestos and approximate amounts of asbestos-containing materials (ACM) expected.

In areas where extensive and complex demolition works and sequencing are required, the input of demolition specialists may be needed, including the preparation of more site-specific demolition methodology statements and phasing plans. This is good practice, particularly when several stakeholders are involved and structures need to be retained.

In addition, this appendix does not consider implosion or explosive methods. The proposed Blasting Strategy can be found in Appendix A5.20 and blasting methods and environmental controls have been discussed in Chapter 5 of the EIAR (Construction Phase), Section 5.5.12.

Information for this appendix has been drawn from the following:

- Dimension, location and use of structures to be demolished are taken from the Schedule for Buildings to be demolished;
- Publications produced by the National Federation of Demolition Contractors and other guidance material and codes of practice as referenced herein; and
- Aerial photography maps for Dublin (years 1995 and 2000) from Geohive database and other relevant electronic sources to determine approximate age and historical use of buildings.

2. Location

2.1 Demolition Areas

A summary of the main demolition requirements for the proposed Project is provided in Table 2.1. There will be other more minor demolition requirements associated with utility structures and boundary walls.

Figure 5.3 accompanying the EIAR Construction Phase Chapter (Chapter 5) details the location of the properties requiring demolition.

Table 2.1: Summary of Main Demolition Requirements

Title	Demolition Category
Swords (Estuary, Seatown, Swords Stations)	Footbridges, community and residential properties: • Malahide Roundabout - 120m footbridge; • Chapel Lane, Swords - 64m footbridge; • R132 Swords Bypass, Mantua, Swords - 101m footbridge; • Seaview Bungalow - single storey house; • Seatown West Bungalow, Seatown West – single storey house; • Estuary Roundabout, Swords – 142m long footbridge; and • Lissenhall Great, Swords - residential building off Ennis Lane; and • Unofficial halting site.
Airside, Swords (Fosterstown Station)	Commercial/ industrial properties: • Smyths Store – 3-storey commercial building; and • Airside HV substations* – 2 no. single storey buildings; and • Northwest of Airside Shopping Centre - communications tower. *Once the diversion and building structure to the new location is complete (as required).
Nevinstown West, Swords (Fosterstown Station)	Residential and commercial properties: • Nevinstown Lodge – single storey bungalow; and • East of Nevinstown Lane – residential two storey building, and • Boland Car Dismantler – 2 no. single storey bungalows and adjoining commercial land.
M50 (Dardistown Depot)	Community / industrial properties: • Whitehall Rangers Club house – single storey community building and adjacent portal frame structure; and • Sillogue Green Road – 2 single storey commercial warehouse buildings.
Santry Demense (Northwood Station)	Residential properties: • North of Santry Lodge Gatehouse – 2 storey residential building; • Santry Lodge Gatehouse (bungalow) – single storey residential building; • Old Ballymun Road opposite Gulliver's Retail Park – redundant single storey residential building, and • Old Ballymun Road opposite Gulliver's Retail Park – communications tower*. *Once the diversion and building structure to the new location is complete (as required)
Griffith Park	Community property; • Sports changing rooms and café.
Glasnevin Station	Commercial/industrial properties during Enabling Works and retaining walls and MGWR tunnel during Civil Works: • Prospect House, Prospect Road - commercial 2-storey building; • Des Kelly Interiors, 1A, Prospect Road - large 2-storey commercial/ industrial building; and • Brian Boru Public House, 5 Prospect Road – 2-storey building.
O'Connell Street Station (Metrolink and Developer delivered scenarios)	Commercial properties to be demolished • 46-49 O'Connell Street Upper; and • 55-56 O'Connell Street Upper. Commercial properties to be partially demolished, maintained and supported: • 43 O'Connell Street Upper – building façade; • 44 O'Connell Street Upper – building façade; • 45 O'Connell Street Upper – building façade; • 52-54 O'Connell Street Upper – building façade; • 57 O'Connell Street Upper- building façade; and • 58 O'Connell Street Upper – building façade.

Title	Demolition Category
Tara Station	Commercial and residential properties: • Ashford House, Tara Street - large 6-storey office building; • Poolbeg Street - large 4-storey office building; • Markievicz Leisure Centre (includes College Gate Apartments) - 6-storey building; • 22 Luke Street - 4 storey residential building (disused); • 24 Townsend Street – 4 storey residential building (disused); and • 25 - 32 Townsend Street - 3 storey building.
Charlemont Station	Industrial/ commercial properties: • 19 and 19a Dartmouth Road - 2 storey commercial building; and • Existing boundary wall; a lane way wall west of Dartmouth Square West - northern half of the wall to be removed and reinstated after construction, southern section of the wall to be protected during construction.

Due to the constrained space available at Tara Construction Compound, special consideration needs to be given to demolition activities at this location. Appendix A5.9 illustrates the demolition approach at this complex location. Further detail on the demolition required at the proposed Glasnevin Station is detailed in Appendix A5.5. This proposed construction site is also very constrained and in order to carry out the works, multiple phasing of activities will be required. There are existing Iarnród Éireann structures (retaining walls and tunnel) that will be demolished and removed as the works are carried out.

3. Demolition Approach

This section provides an overall sequence of operations and approach to be adopted for both the abatement and demolition activities required for the proposed Project. Demolition would be planned, sequenced and undertaken in a safe and efficient manner at all times.

The general approach would include the following key activities:

- Building appraisal and Demolition Plan;
- Building survey;
- Structural survey;
- Demolition Plan and Stability Report;
- Utilities; and
- Hazardous material (including potential Asbestos-containing Materials (ACM)).

3.1 Building Appraisal and Demolition Plan

Prior to carrying out any building demolition, a detailed pre-demolition and building appraisal by means of surveys and appropriate assessments would be required. In general, the surveys would include a building survey and a structural survey with photographs or videos taken for future reference including use of aerial drone surveys.

Based on the findings of these surveys, a Demolition Plan will then be prepared and submitted for approval prior to commencement of demolition activities.

The Demolition Plan would also be accompanied by a report together with structural calculations assessing the stability of the building to be demolished and all affected buildings, structures, streets, land and services.

3.2 Building Survey

Prior to the building survey, the existing record drawings, including layout plans showing adjoining properties, pedestrian walkways, roads and streets, would be retrieved and evaluated.

The building survey will cover the following:

- The existing building construction materials and fabric;
- The existing use and, if possible, the past uses of the building prior to demolition;
- The presence of wastewater, hazardous materials, matters arising from toxic chemicals, flammable or explosive and radioactive materials, etc. and possible presence of materials which can contribute to air pollution and soil contamination.
- Potentially dangerous areas, e.g. abnormal layouts, presence of enclosed voids and non-ventilated light wells which may trap noxious gas at the bottom;

- Adjoining properties and site conditions, such as the existence of slope and retaining wall, wall supporting ground, bridges, distribution substations, traction substations, plantrooms, overhead railway structures, surface track sections, overhead cables or guy wires, and other utility service connections;
- Drainage conditions and possible problems on water pollution, flooding and erosion, especially on sloping sites and receiving water bodies;
- Shared facilities with adjoining building, including common staircases, party walls and possible effect on it, such as self-enclosed walls to the adjoining buildings, during demolition;
- Hoarding and covered walkway requirements;
- Adjoining pedestrian and vehicular traffic conditions;
- Available headroom, clear spaces and distance of building from lot boundary which may affect the loading operation and transportation of building debris during demolition;
- The sensitivity of neighbourhood with respect to noise, dust, vibration and traffic impact;
- Available site area to allow on-site sorting of building debris; and
- Street furniture, such as fire hydrants, parking space/metres, streetlights and street signs, which could be affected by the demolition.

3.2.1 Hazardous Materials

Unless the building survey finds that no obvious hazardous material is present in the building, the Authorised Person will ensure proper sampling and testing for the hazardous materials is undertaken as a precautionary measure.

In the case when hazardous materials, e.g. ACMs or petroleum, are present, they shall be removed and cleaned/disposed of according to the statutory requirements and industry guidance, e.g. Practical Guidelines on ACM Management and Abatement by the Health and Safety and Authority (HSA), British Standard (BS) 6187: Code of Practice for Full and Partial Demolition; and Safe Systems of Works Plans by the Health and Safety Authority.

If the site has previously been used to store chemicals and other dangerous goods, a soil contamination assessment shall be required at the pre-demolition stage and/or post-demolition stage.

3.3 Structural Survey

Prior to the structural survey, the existing record layout, structural framing plans and structural details shall be studied. A registered Structural Engineer shall check the presence of unusual detailing that may cause abnormal structural behaviour during demolition. If existing record plans are available, these plans would be used as reference and preferably be brought along with the structural survey.

The structural survey would generally cover the following:

- The structural materials used;
- The original structural system employed in the design;
- The method of construction;

- Any dilapidation and degree of deterioration of any structural elements;
- The structural conditions of adjoining structures and its proposed pre- and post-construction monitoring, shoring, ground monitoring, utilities monitoring etc., which may be affected by the proposed demolition work;
- The presence of continuous structures that may be truncated by the demolition;
- The structural system and structural conditions of basements, underground tanks or underground vaults;
- The presence of exposed bracing or possible presence of covered bracing;
- The nature of walls, whether it is blockwall, reinforced concrete walls, load-bearing walls or partition walls;
- Any limitation on shoring and other temporary supports; and
- Any fixtures to the building such as signboards.

3.3.1 Investigation and Testing

If no structural details are available, the structural survey shall include on-site measurement and investigation as much as practicable, performing tests and exposing some key structural elements to facilitate checking and proving the existing structure. This would allow the development of procedures that ensure the stability of the building at all stages during demolition.

3.4 Demolition Plan and Stability Report

3.4.1 Demolition Plan

A Demolition Plan will be prepared and approved prior to commencement of demolition works, showing:

- The location of the building to be demolished;
- A detailed topography of the site and its surrounds together with ground level contours and sections of the slopes and ground supported by the building where appropriate;
- Protection and control measures;
- Details of ground removal and/or backfilling; and
- The distances from the building to be demolished to its adjacent buildings, streets, structures and significant street furniture.

The Demolition Plan would also include a layout plan of all floors of the building to be demolished, with adequate sections, showing:

- The occupancy usage of the floors;
- The structural support systems;
- Principal materials of construction;

- The condition of the building, e.g. the degree of deterioration; and

- The relationship of the building to be demolished with neighbouring properties affected by the demolition, which include all adjoining buildings and unauthorised structures, shared staircases, party walls, truncating continuous frames, slopes, retaining wall, overhead cables, guy wires and underground utility services.

The Demolition Plan would indicate the procedure for the demolition of the building; detailed sequence of demolishing particular structural members; and the method of demolition to be adopted including the restrictions on the use of any particular type of equipment.

In the case when powered mechanical plants and equipment are used, the Demolition Plan would indicate the route of movement of powered mechanical plants and equipment including the method of lifting mechanical plant, where necessary, onto the top floors of the structure; any structural alterations required to suit the demolition, e.g. temporary strengthening to suit early removal of any ground floor structure to facilitate vehicular movement at ground floor, or strengthening of deteriorated key structural members; and any shoring, temporary supports and/or floor propping required.

The Demolition Plan would indicate all precautionary measures for the protection of the public including hoardings, covered walkways, catch platforms, catch-fans, scaffolding, protective screens and safety nets.

Figure 3-1: Typical Top-Down Demolition of Multi-Storey Building

The Demolition Plan would indicate the proposed shoring and precautionary measures for all affected adjacent buildings, retaining structures and services at each stage of the demolition works including proposed shoring and temporary support to be provided to the building to be demolished.

The Demolition Plan would also consider the proposed methods for handling and disposing debris, including:

- The permissible temporary accumulation of building debris at upper floors and at ground floor;

- Method of handling demolished building debris;

- The routing and movement of debris from each floor to on grade holding area prior to leaving the site;
- Means of transporting debris off the site;
- Time and frequency of debris disposal off site;
- Record scheme on the tonnage of each truck load, truck licence plate, driver's name, trip tickets and location of dump site;
- The site supervisory personnel responsible for the debris management system; and
- A temporary parking layout for mobile machines and trucks, if necessary.

3.4.2 Stability Report including Calculations

When required, a Stability Report would supplement the Demolition Plan and include as a minimum the following parts:

- In the case when powered mechanical plants or equipment are used, structural calculations for all temporary supports and bracings;
- A report on the stability of neighbouring buildings, adjoining properties, party walls, streets, land and services which may be affected by the demolition work;
- Structural calculations for any temporary or permanent supports required to these neighbouring buildings, adjoining properties, and party walls; and
- A report with calculations demonstrating that the demolition work will not render inadequate the margin of safety of, or cause damage to, any building, structure, street, land or services.

3.5 Utilities

Prior to beginning any demolition or construction activities, the contractor would identify the locations of all utilities within the proposed Project work area. Based on a review of the drawings, it is anticipated that the utilities within the work area or adjacent to the work area would include electric, gas, water and sanitary sewer. All electrical relocations, isolations and de-energizations would be performed by a licensed electrical subcontractor.

3.5.1 Termination of Utilities

Prior to actual demolition, as part of the pre-demolition assessments, the contractor would liaise with all available utility companies and the local authority to:

- Keep records of available utilities leading into the premises;
- Agree process by which utilities will be made safe and terminated; and
- Agree measures to protect existing utilities.

3.5.2 Effects of Demolition on Utilities

The Demolition Plan would ensure that, during the course of demolition, no existing utilities near the demolition sites are affected by the demolition operation.

3.5.3 Common Utilities

The common utilities encountered in building demolition generally include the following:

- Electricity;
- Water;
- Gas;
- Telecommunication and cable services, including fibre optics;
- Drainage sumps, tanks, attenuation;
- Overhead and underground cables; and
- Surface water and foul sewers.

All utility companies and relevant agencies shall be consulted prior to demolition of the structure.

3.5.4 Maintenance of Certain Utilities

During demolition, the following basic utilities shall be required to provide a safe and healthy working environment:

- Temporary water supply would be required to provide water spraying during demolition for dust pollution abatement measures;
- Welfare facilities;
- Temporary telecommunication link between the demolition site and outside organisation shall be maintained for both security and communication reasons; and
- Temporary electricity supply for lighting and other construction use.

In the case when temporary utilities are available, all such temporary utilities, including electrical fittings, shall be weather-proofed. It is envisaged that the provision of services is part of the Enabling Works Scope.

3.6 Hazardous Materials

3.6.1 Main Types of Asbestos

The three main types of asbestos that may be encountered when carrying out demolition work are as follows:

- **Chrysotile (white asbestos):** Chrysotile is the most commonly used type of asbestos and is often contaminated with trace amounts of tremolite. Chrysotile fibres are usually fine in texture, possessing high flexibility and good heat-resistant properties, making it ideal for use in cement, brake pads/linings and roofing materials.
- **Amosite (brown asbestos):** Mined mostly in Africa, amosite is a particularly strong and heat-resistant type of asbestos that was commonly used in cement sheet, plumbing insulation and electrical insulation. Though all types of asbestos are toxic, amosite asbestos exposure has a comparatively higher cancer risk.

- **Crocidolite (blue asbestos):** Crocidolite has very thin fibres and, if inhaled, are easily lodged in the lungs. Its thin fibres and brittle nature make crocidolite one of the most harmful forms of asbestos, as it easily breaks down and leads to asbestos exposure.

If hazardous materials, such as ACM, petroleum contamination and other hazardous materials, exist in the building, further investigation and removal of such hazardous material or contamination would be carried out by a specialist. Figure 3-2 shows a typical set up for containment and safe removal of ACM.

Figure 3-2: Typical Set Up for Containment and Safe Removal of ACM

3.6.2 Asbestos-Containing Material

Specialists shall be employed to take samples and get them tested for ACM. If ACM are discovered, a specialist contractor shall be employed to remove it. The asbestos waste should be handled, stored and disposed of as chemical waste in accordance with the Safety Health and Welfare at Work (Construction) Regulations 2013 (SI. No. 291 of 2013).

3.6.2.1 Asbestos Risk Assumptions in Buildings to be Demolished along the Proposed Project

Asbestos risk assumptions were needed to understand the impact of asbestos management and abatement activities on the construction programme. To provide these assumptions, a preliminary risk assessment of exposure to asbestos from ACM has been done on the buildings listed in the demolition schedule.

The practical guidelines on ACM Management and Abatement from the Health and Safety Authority have been followed in carrying out a high-level assessment of the likelihood of asbestos risk for these buildings. To carry out this assessment, the following assumptions have been made:

- The likelihood that a building may have ACM is initially based on approximate age of construction of the building and its use. If a building was constructed before the year 2000, then it was presumed that it may have ACM. To date, no asbestos surveys for the buildings listed on the demolition waste schedule have been provided to confirm that there is strong evidence that they do not have ACM.

- Approximate age was mainly determined by aerial photography maps from years 1995 and 2000 (http://map.geohive.ie/mapviewer.html). The use type of the building was determined based on observation from 3D imagery from Google Maps Street View images and based on electronic references found for some of the buildings.

- High likelihood of asbestos risk was presumed for buildings that had an old or disused condition, or that were constructed between 1900 and 1980. These are buildings where the following high-risk types of ACMs may be very likely found: loose fill asbestos, lagging and insulation, sprayed coatings, asbestos insulating boards.

- Small likelihood of asbestos risk was presumed for buildings where no high risks ACMs are present, due to its condition and type of use.

- The small likelihood of asbestos in footbridges has been derived from possible presence of asbestos concrete drainage pipes. This needs to be confirmed from as-built drawings or related construction plans.

- For buildings constructed later than year 2000, it was presumed that they were asbestos free, as use of ACM was prohibited in 1999. Therefore, a refurbishment and demolition survey for asbestos would not be needed.

Estimations of quantities of ACM in buildings were derived using information from the Strategic Forum for Construction Report 010 (2010) and from two case histories found in the report, Overview of Demolition Waste in the UK, a study undertaken in 2008. Both reports indicate ACM waste quantities between 1% to 2% of the total of waste generated in a demolition. Assuming a worst-case scenario, 2% of total construction materials indicated in the demolition waste schedule has been taken as the expected ACM quantities for the buildings to be demolished along the proposed Project route.

3.6.3 Indicative ACM Removal Sequencing and Schedule

The site investigation, testing, sampling and preparatory works for ACM removal is a highly specialised operation, and one which requires a carefully thought-out methodology and phasing. The likely ACM removal (indicative only) would be as follows:

PHASE 1 – Survey, testing and sampling (1–6 weeks)

- Assess and test technical state, collect air and material samples;

- Develop approach for disposal/staff training; and

- Prepare methodology, disposal procedures and risk assessment.

PHASE 2 – ACM demolition/removal set up (8–16 weeks)

- Set up protective screening, air quality monitors, permits, signage, zoning etc.;

- Set up hazardous waste storage containers;

- Seal and secure building: seal all windows, openings and doors;

- Personal protective equipment; and

- Commence dismantling of asbestos products, e.g. ACM panels or other materials.

PHASE 3 – ACM removal preparation (1–4 weeks)

- Prepare waste for storage, transport, disposal, secure bagging/labelling, etc.

PHASE 4– ACM disposal (1–3 weeks)

- Remove and transport ACM by approved transport equipment/vehicles and appropriate licensed carriers; and
- Dispose ACM at specially prepared and licensed hazardous waste facility.

PHASE 5 – Final reporting and handover (1–3 weeks)

- Provide final waste transfer cards/documentation;
- Provide final report on air quality testing; and
- Demobilise from site.

The indicative ACM removal and sequencing above is based on the assumption that it would take around three to eight months to remove the ACM from a five-storey building approximately 40m x 50m that contained ACM in internal walls, lagging and ceilings.

Actual durations would be determined on a case-by-case basis once access is available, and the extent and the type of ACM has been classified by on-site testing. As noted in Section 3.6.1, the type of ACM would likely have a significant bearing on the overall ACM removal sequencing and duration.

3.6.4 Soil Contamination Material

Where there is possible soil contamination material, trained and experienced specialists would be employed to prepare a soil contamination test proposal and submit such proposal to the relevant authority for consideration. Upon agreement by the relevant authority, and completion of the tests, a soil contamination assessment shall be submitted to the relevant authority for acceptance. If remedial works were to be required, the remedial proposal shall be submitted to the relevant authority for approval before carrying out the remedial works.

4. Precautionary Measures

4.1 General

Site safety features would emphasise protection of the public, particularly pedestrians, vehicular traffic and the adjacent properties. Proper safety features shall be designed by the contractor/registered Structural Engineer to make sure that the demolition can be carried out safely and the site personnel is protected.

The registered Specialist Contractor (Demolition) would normally carry out the demolition works, including precautionary measures in accordance with the approved plans and other related documents, and provide continuous supervision to the works.

4.2 Hoardings and Covered Walkways

Site hoardings are structures most commonly about 2.4m in height, using a plywood sheet (but increasingly using proprietary steel of plastic panels), and are of solid construction. Hoardings are considered to be temporary works, and therefore consideration must be given to BS 5975:2005+A1:2011 and NFDC Guidance DRG 106:2014 for procedures for their management and control. This includes requirements for the appointment of a Temporary Works Coordinator (TWC) and for the preparation of a register of the temporary works on the site.

The primary purpose of hoardings and covered walkways is to provide protection to the public during the construction or demolition of buildings. Generally, hoarding isolates the demolition site from the public, thus preventing unauthorised access and trespassing. Good practice for hoarding design and construction is referenced in HOARDINGS – A guide to good practice (document reference TWf2012:01) produced by the Temporary Works Forum.

A covered walkway, in conjunction with a catch platform, provides additional protection to the pedestrian traffic against falling debris. The TWC/registered Structural Engineer shall design them to suit individual site circumstances. Suggested designs for hoarding, covered walkway and catch platforms are indicated in Figure 4-1, Figure 4-2 and Figure 4-3.

Figure 4-1: Typical Standard Hoarding Protection

Figure 4-2: Typical Covered Walkway

Figure 4-3: Example of Catch Platform

Debris would not be allowed to accumulate on the roof of the covered walkway. The covered walkway would not be used for any other purposes such as storage of building materials and equipment inside or above the covered walkway.

If it is intended to build a temporary contractor's shed over the covered walkway, it must be structurally independent of the covered walkway. The roof of the contractor's shed shall sustain the design load criteria for the catch platform or covered walkway, whichever is applicable.

The roof of the covered walkway shall be pitched inwards to better contain the debris and for roof drainage. Upstand edge board of 1.1m or higher, measured from the toe of roof line of the catch platform's outer edge, shall be provided to retain the fallen debris.

A system of temporary lighting shall be provided for the covered walkway and shall be maintained in good order.

4.3 Scaffoldings and Screens

Metal shoring and scaffold systems would be used for top-down demolition projects. Both shoring and metal scaffold systems are considered acceptable provided that they are erected according to the Code of Practice for Access and Working Scaffolds (HSA, 2018).

Figure 4-4 provides a typical example of a screened structure in readiness for demolition. The screening mainly used is a reinforced membrane, e.g. 'Monarflex' or similar approved product.

Figure 4-4: Example of Demolition Scaffolding and Screening

Two layers of protective screen would normally be placed over the scaffolds to completely enclose the building structure to retain dust and small debris. Tarpaulin and heavy-duty nets shall be used to cover the exterior face of the scaffold. Tarpaulin shall be placed over the net.

The protective screens shall be secured to the scaffoldings at intervals of no more than 2m, both horizontally and vertically, or the width of the net, whichever is less. The screens shall have a minimum overlapping width of 3m.

4.4 Temporary Supports

Temporary supports to the structure or the elements of the structure being demolished shall be provided for any, or a combination, of the following conditions:

- When the whole or any part of the structure is subjected to excess loading derived from the demolition activities, movement of powered mechanical plant or debris accumulation;
- When any part of the structure or any element being demolished is not self-supporting; or
- When the temporary stability of the structure or its elements could be impaired as a result of the demolition activities;
- Temporary supports shall not be removed until its supporting loads are completely removed.

On the other hand, temporary supports shall be removed as much as possible and practicable after demolition. If temporary supports have to remain, the TWC, registered Structural Engineer and registered Specialist Contractor (Demolition) shall be responsible for routine inspection and maintenance of such temporary works until they are completely removed.

4.5 Protection of Properties

Stability treatment shall be provided to protect building elements that may be affected by the demolition project. The design of the bracing system shall be based on a structural assessment and engineering evaluation to provide necessary and sufficient protection for the affected properties.

The key issues to consider when protecting properties during demolition are as follows:

- Party walls and external walls: normally undertaken by the manual method with extreme care to prevent any damage to the party wall or the external wall.
- Waterproofing: waterproofing may be achieved by cement mortar treatments and would be carried out as soon as practicable. In general, such waterproofing work shall be performed as building demolition progresses.
- Structural supports: The exposed party walls or unprotected external wall may be temporarily supported by timber raking shores or installation of stiffeners consisting of structural steel members with concrete cover or other corrosion protective system as designed by the TWC contractor.

4.6 Protection of Traffic

Any closure of roads and walkways may seriously impact the traffic/pedestrian circulation and cause disruption to the public. Therefore, as far as practicable, the installation of the precautionary measures and the demolition operation which causes any closure of traffic lanes shall be avoided.

If unavoidable, prior permission/arrangement of the relevant authority would be obtained. Temporary closure of a traffic lane would likely be considered for night work. Temporary closure of a traffic lane may also be considered for exceptional cases where there are no other practical alternatives to safely demolish certain building elements.

4.7 Debris and Waste Handling

For debris and waste handling, the following control measures and approach would be implemented.

4.7.1 Waste Handling via Chutes, Lift Shafts and Openings

- Debris waste and other materials shall not be thrown, tipped or shot down from a height where they are liable to cause injury to any person on or near the site.

- Existing lift shaft, light well and openings on floor may be used to convey debris down the building floors. Areas adjacent to the openings of these features used as a chute shall be barricaded when they are not in use. Warning signs shall be posted to prevent workers from entering the area. As an option, plastic chutes may be used inside the floor openings and lift wells to minimise noise and confine the falling debris.

- Openings on the floor may be used to convey debris. If openings are created on the floor, the total openings shall be less than 25% of the total aggregate floor area. Each opening shall not be larger than 900mm × 900mm unless demonstrated with justifications having regard to the safety of the remaining structure and minimising the possible risks arising from the impact force induced. Openings shall not cut through structural support elements that may affect the stability of any structural components.

- No demolition materials shall be allowed to fall freely outside the building unless it is confined within a chute. If exterior chutes are used, adequate clear spaces shall be provided for their operation. Temporary refuse chutes assembled from old metal barrels shall not be used. The chutes shall not cause any obstruction to the public. A dust barrier shall be provided if the chute outlet is near public access. The chute shall be designed and constructed with adequate strength and support to allow safe conveyance of debris.

4.7.2 Debris Recycling

- Effective site management and practice can not only prevent the mixing of the inert portion together with the non-inert portion of construction and demolition waste but can also facilitate and allow on-site sorting and separation at source of construction and demolition waste.

- The method of ‘selective demolition’ should be adopted as far as practicable. This involves demolition and removal of wastes of the same category one at a time. The goal is to facilitate recycling of wastes for beneficial reuse, thus minimising the burden on municipal landfills. In general, domestic wastes (e.g. furniture and household appliances), metal components (e.g. window frames and pipes), timber components (e.g. doors and wooden floors), and other wastes (e.g. tiles, asphaltic materials and ceramic products) should be removed first. Most of these materials may be recycled. The building demolition shall begin after all the above non-structural materials have been stripped and removed.

- The sequence of demolition shall be planned to allow the separation and sorting of building materials.

- Concrete and/or brick debris shall be broken down into smaller sizes and separated from reinforced steel for disposal.

- Crushing demolition arisings on-site using mobile concrete crushing equipment offers a range of environmental, logistical and financial benefits. Crushing reduces pollution by drastically cutting traffic movements to and from the site. It also keeps concrete debris out of landfill. The aggregate produced could be utilised as a piling mat or as a substitute for virgin aggregates.

- Concrete debris may be pulverised into aggregate size and used for road base, temporary haul roads, fill materials or aggregates for concrete. Old bricks may be salvaged for reuse as architectural features or other uses.

- Broken concrete may also be disposed of at construction and demolition (C&D) materials recycling facilities for processing into recycled products and aggregates for beneficial reuse. In the event that broken concrete is mixed with some other wastes, broken concrete should be sorted out on-site from the mixture of wastes, before disposal at a C&D materials recycling facility.

4.7.3 Dust Minimisation

To prevent dust generation during the demolition process and debris hauling, water spraying shall be applied as required. The registered Specialist Contractor (Demolition) would ensure proper control of water supply and floor drainage system to avoid flooding.

Figure 4-5 and Figure 4-6 indicate the typical dust control measures used on-site.

Figure 4-5: Example of Direct Dust Control by Damping Down

Figure 4-6: Example of Dust Control Using Water Mist System

4.8 Environmental Precautions

Demolition has been considered and assessed throughout various environmental chapters in this EIAR, all of which feed into the draft Construction Environmental Management Plan (CEMP) (Appendix A5.1 of this EIAR).

Pre-demolition surveys will be undertaken to confirm the proposed methodology and provide sufficient detail to allow the full management of the demolition and resulting materials. Pre-demolition surveys will include appropriate hazardous materials surveys to identify all asbestos containing materials and other hazardous materials that may be present. Demolition survey mitigation measures to limit dust, noise, vibration and air pollution (e.g. through dust and fumes) will be implemented.

The monitoring of noise, vibration and dust will be carried out on a regular basis during the demolition phase both on-site and in sensitive areas adjacent to the site. Environmental control measures are detailed in Appendix A5.9 and the draft CEMP in Appendix A5.1 of this EIAR.

The general requirements to minimise environmental impacts from construction sites can also be applied to demolition processes. The following sections contain some of the procedures to be adopted.

4.8.1 Air Pollution

Concrete breaking, handling of debris and hauling are the main sources of dust from building demolition. Dust mitigation measures would be adopted to minimise dust emissions. Burning of waste would not be allowed.

The contractor(s) will adhere to best practice air quality measures for construction activities including but not limited to:

- IAQM's Guidance on the Assessment of Dust from Demolition and Construction (IAQM 2014); and

- Dublin City Councils Air Quality Monitoring and Noise Control Unit's Good Practice Guide for Construction and Demolition (DCC, 2018).

Relevant guidelines, legislation and dust mitigation measures are detailed in Chapter 16 (Air Quality) of this EIAR and in the Draft CEMP (Appendix 5.1). A draft Dust Management Plan is provided in Appendix A16.4 of the EIAR.

4.8.2 Noise

Noise emissions arising from the demolition works may include the use of powered mechanical equipment, such as pneumatic breakers, excavators and generators, the erection of temporary scaffolding and loading and transportation of debris. Noise emissions may impact sensitive receivers near the demolition site.

Relevant guidelines and legislation relating to construction noise emissions are detailed in Chapter 13 (Airborne Noise) of the EIAR. Noise mitigation measures are also detailed in Chapter 13 and in the Draft CEMP (Appendix 5.1).

4.8.3 Water

Surface water run-off from demolition sites, including wastewater arising from damping down activities, will require careful management.

Prior to the commencement of demolition, the contractor(s) will prepare method statements for the discharge of construction water. Where possible, surface water run-off will be segregated and discharged to watercourses or to surface water sewers, subject to appropriate silt management and the agreement of the Local Authority/Environmental Protection Agency (EPA). Wastewater from dust suppression and contaminated run-off will be discharged to foul sewer with the agreement of Irish Water. Where this is not possible, wastewater will need to be tankered off site to a suitably licensed treatment facility. On-site water treatment may be required to meet discharge licence conditions, typically involving settlement and/or flocculation to remove suspended solids.

4.8.4 Hazardous Materials

If ACM needs to be removed, an Asbestos Abatement Plan would be submitted for approval before the asbestos abatement work starts.

The asbestos abatement works shall be carried out in accordance with all statutory regulations and the Practical Guidelines on ACM Management and Abatement produced by the Health and Safety Authority before demolition.

Other materials, such as Liquified Petroluem Gas cylinders, toxic and corrosive chemicals and any other hazardous materials have to be identified and properly handled and removed before the building is demolished.

The management of waste must fully comply with the relevant authorities' requirements.

5. Demolition Methods

5.1 General

The choice of demolition method depends on details of the proposed project, site constraints, sensitivity of the neighbourhood and availability of equipment.

Top-down methods are applicable for most sites, particularly for those situated in busy urban areas. Other mechanical methods applied from the outside of the building may be suitable for projects that have sufficient clear spaces.

In certain circumstances, demolition by handheld tools or the cut and lift process may be a safe solution.

The suggested procedures described in this section are recommended good practice for demolition of common structural elements only. Each site has its specific features and conditions. The method, including detailed procedures, shall be designed to accommodate the specific project requirements. In general, demolition should be carried out in the reverse order of construction, as far as appropriate.

5.2 Top-Down – Manual Method

The top-down method proceeds from the roof to ground in a general trend. There are particular sequences of demolition which may vary, depending on site conditions and structural elements to be demolished.

For reinforced concrete buildings, jack hammers are commonly used to break down the concrete. Oxy-acetylene torch could be used to cut the reinforcements.

The structural elements shall be broken down gradually or by alternate methods as described in the following sub-section. The reinforcements shall remain until all the concrete connecting to or supported by the reinforcement is broken away or when its support is no longer required.

The demolition sequence shall be determined according to actual site conditions, restraints, the building layout, the structural layout and its construction.

In general, the following sequence would apply:

- Features attached to the external walls shall first be demolished prior to demolition of main building and its internal structures on each floor.
- When demolishing the roof structure, all lift machine rooms and water tanks at high level shall be demolished in “top-down” sequence to the main roof level.
- Demolition of the floor slabs shall begin at mid span and work towards the supporting beams.
- Non-load-bearing walls shall be removed prior to demolition of load-bearing walls.
- Columns and load-bearing walls shall be demolished after removal of beams on top.

If site conditions permit, the first-floor slab directly above the ground floor may be demolished by machine sitting on ground level and mounted with demolition accessories.

5.3 Top-Down – By Machines

The sequence of demolition by machine is typically the same as the top-down manual method, except that most of the demolition is done by mechanical plant as shown in Figure 3-1.

The demolition begins with the lifting of the mechanical plant on to the building top floor as shown in Figure 4-4. When rope or tie wire is used for pulling, the workers shall be protected or stay away from the area within reach of the rope or tie wire. The wire strength shall be at least four times the anticipated load. The rope or tie wire shall be checked at least twice per day to ensure that it is in good working condition.

Figure 5-1 shows a typical example of the top-down method by machine utilising a small tracked 'Kubota' mini-excavator fitted with a rock-breaking attachment.

Figure 5-1: Top-Down Demolition Method – By Machine

5.3.1 Supports for Machines

The loading to be imposed on the floors by the mechanical plant shall be checked. If needed, propping shall be installed at floor levels below the working floor to safely support the operation of the mechanical plant. The movement of the mechanical plant shall only be within the propped area. The movement of the mechanical plant shall be prohibited in the following areas:

- Within 2m of the building edge;
- Within 1m of any floor openings; or
- Any cantilevered structures.

Markings such as ribbons, paints or other appropriate means shall be used to identify the propped area and limits of the mechanical plant movement. The extent of the propping shall be determined based on the anticipated operation, the allowable loading on the floor slabs and the site conditions.

5.3.2 Lifting of Machinery

The mechanical plant shall be lifted onto the roof of the building using a mobile crane or other appropriate means as approved and checked by the contractor. Prior to the lifting operation, propping shall be installed on the floors beneath the roof in accordance with the approved design.

The operating area shall be blocked off during the lifting operation.

5.3.3 Temporary Ramp Construction

The machine shall descend down to the next floor by means of a ramp. The ramp may be a temporary structure or other appropriate design. The slope of the ramp shall be no steeper than 1.75 to 1 or as recommended by the machine manufacturer. Temporary structures would be designed and constructed. Propping requirements for the temporary access ramp would likely be necessary and installed by the demolition contractor (See Figure 5-2).

As an alternative, the machine may also be lowered to the next floor using a mobile crane or other appropriate means.

The demolition sequence shall be determined according to the actual site conditions, restraints, original building layout and its construction. In general, the following sequence shall apply:

- Prior to demolition of internal floors, all cantilevered slabs and beams, canopies and adjoining structures shall first be demolished.
- The structural elements, in general, shall be demolished in the following sequence:
    - Slab;
    - Secondary beams; then
    - Main beams.
- Mechanical plant shall descend from the floors with temporary access ramp, or be lowered to the next floor by lifting machinery or other appropriate means(See Figure 5-3)
- When a mechanical plant has just descended from the floor above, the slabs and beams in two consecutive floors may be demolished by the mechanical plant simultaneously. The mechanical plant may work on structural elements on the same floor and breaking up the slabs on the floor above.
- The wall panel, including beams and columns, shall be demolished by gradually breaking down the concrete or by pulling them down in a controlled manner.

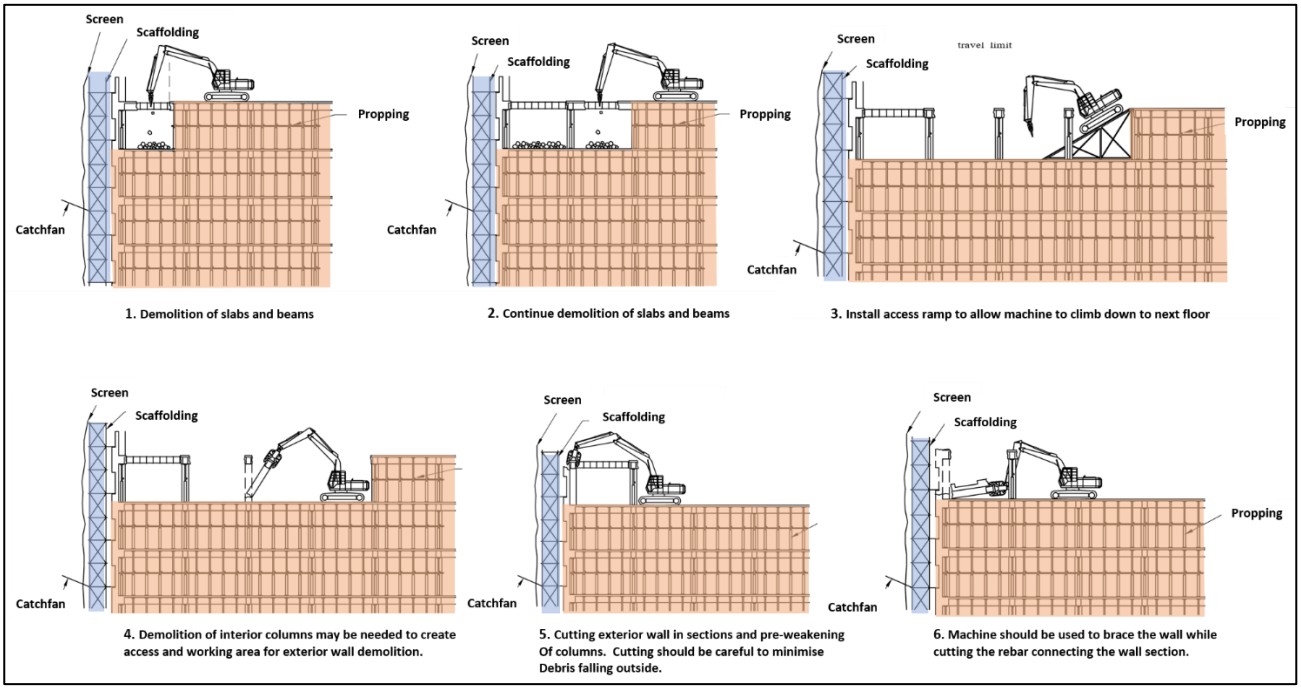

Figure 5-2: Typical Top-Down Demolition Sequence

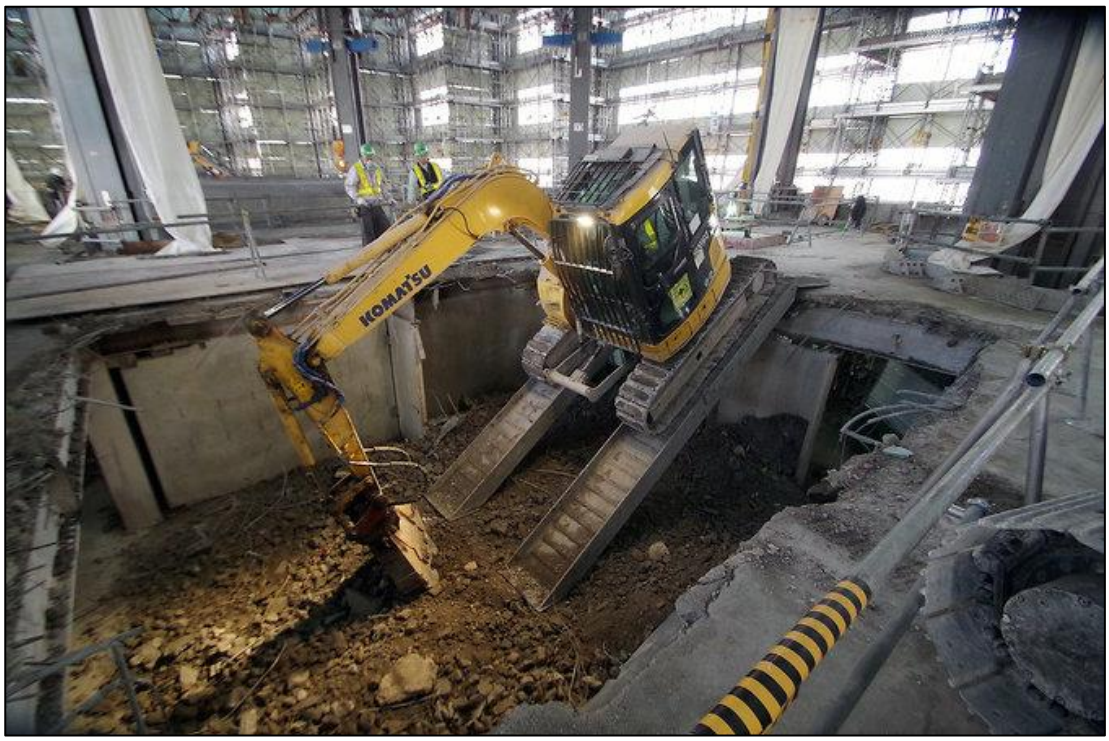

Figure 5-3: Top-Down Method – Mini-Excavator Access Ramp

5.4 Mechanical Method by Hydraulic (High-Reach) Crushing Arm

5.4.1 General

The crushing attachment breaks the concrete and the reinforcement by the hydraulic thrust through the long boom arm system. The hydraulic crushing arm can be operated from the ground outside the building up to a 15m working height. This method is also suitable for dangerous buildings, silos and other industrial facilities. Figure 5-4 illustrates the typical operation of hydraulic crushing with long boom arm. Because of its quietness, it should be used wherever practicable to reduce environmental impacts.

Figure 5-4: Top-Down Demolition Method – By Hydraulic Crushing Arm

5.4.2 Application Criteria

- The operation shall have a minimum clear space of 1/2 the building height as a safety zone for the falling debris.
- The equipment shall be inspected and maintained periodically to make sure the equipment is in good and safe condition. The excavator shall operate on firm ground that can support the machine during the crushing operation.
- Except for special applications, each section of the structure shall be demolished in a top-down sequence to ensure stability of the structure.
- Debris may be used to build up a platform for the excavator to extend the range of reach. It is important that the debris is densely compacted to support the operation of the excavator. The platform must be

flat and the slope must be stable. The height of the build-up platform shall be limited to 3m. The side slope of the temporary platform shall not be steeper than 1:1 (horizontal to vertical) unless the condition allows a steeper slope. The slope of access ramp for the machine shall be in accordance with the manufacturer's recommendation. The width in both directions of the platform shall be at least one and one-half the length of the machine to allow safe manoeuvre during the demolition operation.

- To minimise the dust impact, the structure shall be pre-soaked with water before demolition. Water shall be continuously sprayed during the crushing operation.

- Debris may fall out of the building during the demolition. The site shall be completely fenced off. There shall be 24-hour guarded security to allow only authorised personnel to access the site. During the operation of the hydraulic crushing arm, there shall be no worker within the machine operating area or inside the building.

- The operator shall possess the essential skills and significant experience in the crushing operation. There shall be a spot person to assist in the operation and alert the operator of any potential problem during the operation.

5.5 Other Methods

Other methods of demolition, which may be used on the proposed Project, are described in this section.

5.5.1 Non-Explosive Demolition Agent

Non-Explosive Demolition Agent (NEDA) is a static demolition agent. When the reaction takes place in a confined drill hole, the NEDA generates an expansive pressure to crack and break concrete and stone.

The NEDA is a suitable application in a restrictive environment where noise, flying debris and vibration are less tolerated. A drilling pattern shall first be designed. For large projects, test breaking shall be performed. The NEDA shall be mixed with water to form a slurry and immediately placed into the pre-drilled holes. The loading intensity and water content shall be controlled to optimise the expansive pressure and prevent blow-out of the NEDA. The breaking effect of NEDA is relatively small compared to explosives. Secondary efforts are required to further break down and remove the debris by mechanical means.

NEDA may be used on foundation works, pile caps or structures that are fully supported.

When used in rock, NEDA should be contained within strong, flexible, impermeable bags to prevent uncontrolled entry into rock joints.

5.5.2 Saw Cutting

Saw cutting is suitable for alteration and additional works where accuracy in the cutting is important and the tolerance to noise and vibration is very limited. It can be used to cut concrete slabs and wall elements into segments. An entire building may be dismantled by saw cutting. Saw cutting generally includes conventional disc saw and chain saw, diamond core stitch drilling and wire saw.

5.5.2.1 Wire Saw Cutting

Wire saw cutting comprises a special steel wire often impregnated with diamond beads to increase its cutting ability. The wire saw method is suitable for projects that require precision and total control of demolition work. First, a hole is pre-drilled for the passage of the diamond wire, then the wire cutting operation follows. Because of

its flexibility, it may be used for hard-to-reach areas. Its flexibility and range of application are depicted in Figure 5-5.

Figure 5-5: Wire Saw Cutting

5.5.2.2 Diamond Core Stitch Drilling

Diamond core stitch drilling may be adopted to cut concrete elements by continuously coring a set of holes to carve up the concrete structure. The thickness of the concrete to be cut depends on the depth of the drilling or coring equipment. Diamond core stitch drilling is particularly suitable for removing existing pile cap for construction of large diameter bored pile foundation.

5.5.2.3 Management of Process Water

The sawing and drilling operations require large amounts of water to cool down the blade which cuts through the concrete at high speed. Provision shall be made to provide a water source for the operation and for the disposal of the cooling water.

5.5.3 Cutting and Lifting

Cutting and lifting involve the initial cutting of the structure into individual pieces or segments, and then lifting the pieces onto the ground for further demolition or hauling away. Slabs can be cut into segments and then lifted off for further cutting into smaller pieces before disposal.

Precast concrete structures can be cut into pieces and then lifted off in the reverse order of how they would have been put together during construction. Cutting and lifting may be applied to safely remove projections such as canopies, architectural features, balconies and bay windows. The typical procedures for cutting and lifting are as follows:

- Prior to cutting, the structural stability of the remaining structure shall be checked.
- The structural element to be removed shall be secured, either by temporary supports or by tie wires connected to lifting appliances. The lifting appliances must have adequate capacity to support the weight of the structural section. The wire strength shall not be less than four times the anticipated loads.
- The lifting appliance, cutting by disc saw, chain saw and diamond wire saw shall comply with all relevant health and safety legislation.
- After cutting, the structural element shall be lowered to the designated area in a controlled manner. Free falling shall be avoided.

5.5.4 Cutting Down Pile Heads

For this operation, specialist hydraulic rams are used. After the pile head is exposed, the pile head cutter is simply placed over the pile using a tracked excavator. The rams are then engaged at the required level to cut the unwanted concrete and expose the pile rebar for subsequent construction of the pile cap or beam. Figure 5-6 shows this system in operation.

Figure 5-6: Pile Cutting/Demolition Method – By Hydraulic Crushing

6. Construction and Demolition Waste Management Plan

The contractor(s) will develop a Construction and Demolition Waste Management Plan (C&D WMP), which incorporates all of the measures outlined in the Draft CEMP (see Appendix 5.1 of the EIAR) and the Excavated Material Management Strategy (see Appendix 24.1). The C&D WMP will identify how waste arisings are to be controlled and managed during the course of the proposed Project, in particular how waste prevention principles will be applied and how on-site waste will be minimised.

The C&D WMP will outline methods to achieve waste prevention, maximum recycling and recovery of waste and provide recommendations for the management of the various anticipated waste streams.

The C&D WMP will identify how waste arisings are to be controlled and managed during the course of the proposed Project, in particular how waste prevention principles will be applied and how on-site waste will be minimised. The C&D WMP will be written in accordance with the best practice guidance (DoEHLG 2006).

The C&D WMP will include:

- Roles and responsibilities with regards to waste management;
- An analysis of the likely waste arisings;
- Specific waste management objectives for the proposed Project;
- Methods proposed for recycling / reuse of waste;
- Material handling procedures;
- Procedures for keeping records of all waste and materials which are removed from site; and
- Proposals for training of the workforce in waste management procedures and requirements.

A number of waste management practices will be implemented by the Contractor(s) in order to manage waste arisings in an orderly fashion to minimise the impact in so far as is possible.

- A regular programme of site tidying will be established to ensure a safe and orderly site;
- Debris netting will be erected to prevent materials being scattered by the wind;
- Food waste will be strictly controlled on all parts of the site in order to minimise the attraction of vermin and other pests;
- In the event of any litter or debris escaping the site, it will be collected immediately and removed to storage on site, and subsequently recovered / disposed of in the normal manner;
- Waste receptacles such as skips will be secured so as to minimise impact from fly-tipping; and
- Waste will be collected in a timely fashion so as to prevent overly large volumes of waste accumulating.

The management and disposal of wastes arising from demolition activities is assessed in Chapter 24 of the EIAR (Materials & Waste Management).