

**SUMMARY REPORT OF ASSESSMENT OF THE IMPACT
OF FILMING ACTIVITIES AT DWEJRA, GOZO, ON
GEOLOGY, GEOMORPHOLOGY AND PALAEOLOGY,
LANDSCAPE AND VISUAL SCENE, PROTECTED AREA
INTEGRITY, AND TERRESTRIAL AND MARINE
ECOLOGICAL RESOURCES**

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1 Introduction

In October 2010, extraneous sediment originating from a local quarry was deposited at a site (henceforth the Area of Deposition, AoD) within the Qawra-Dwejra area, Gozo, to serve as dressing for a film set in connection with filming for the television series 'Game of Thrones'. Deposition of the sediment was made by a sub-contractor commissioned for the purpose following the granting of a permit¹ issued by the Malta Environment and Planning Authority (MEPA) to Pellikola Ltd. Besides requiring that the sediment be removed after filming was completed², the permit was subject to twenty-six consent conditions, of which conditions 23 and 24 respectively stated that:

- *At Dwejra, permitted activities within "Area 1" shall be confined to a spatial extent of 750m²;*
- *Surfacing and dressing of sites within Dwejra and Rdum id-Delli, other to the levelled rock surface at id-Dwejra, is prohibited.*

Other consent conditions highlight *"the responsibility of the applicant/production agency organizing the activity to ensure that all reasonable precautions are taken to prevent damage to cultural and natural heritage, including the environment in its broadest sense and protected sites or areas"*, and to ensure that the activity conforms to the permit conditions. The conditions also emphasised that all works shall be carried out in strict accordance with the issued consent and with approved application, plans and supporting documents. In cases of ambiguities and discrepancies between these documents, the consent conditions are listed as taking precedence over approved plans.

Before the extraneous sediment was removed from the site, the material underwent consolidation and cementation following heavy rainfall. As a result, the contractor commissioned to remove the sediment initially used heavy machinery and impact tools to remove the material. The MEPA intervened, and requested that further removal of the extraneous sediment be done manually.

In view that both deposition of the extraneous sediment and its removal may have caused degradation of the natural resources in the AoD and its environs, and given that the site concerned forms part of the Dwejra-Qawra Special Area of Conservation (SAC), which is also a candidate World Heritage Site, the MEPA commissioned Dr Louis F. Cassar and a team of specialists to undertake an assessment of the impact of filming activities according to specified Terms of Reference (TOR)³, with respect to the following:

- Geology, geomorphology and palaeontology;
- landscape and visual scene;
- protected area integrity;
- terrestrial ecological resources
- marine ecological resources

The appointed specialists undertook the required assessment during late November 2010 and early December 2010, the outcome of which is presented in three separate but related reports. The present submission constitutes a summary of these three reports, which are listed below:

¹ Document: *"Permit Application for the Production of a Television Series titled 'Game of Thrones'"* Pellikola Ltd, Qormi, 08 July 2010 [made available by MEPA].

² Document: *Consent Conditions Game of Thrones Sept 2010* [made available by MEPA]

³ Document dated 24 November 2010 and titled *Dwejra-Expert Assessment-TORs-Final-24Nov10*.

Cassar L. F., Conrad E., Gauci P. & Borg R., 2010. Assessment of the impact on assets pertaining to geology, geomorphology and palaeontology, landscape and visual scene, and protected area integrity, of filming activities carried out at Dwejra, Gozo, between September 2010 and November 2010. Independent consultants, Malta, 33pp. [Unpublished report].

Cassar L. F., Lanfranco S. & Schembri P. J., 2010. An assessment of the impact on terrestrial ecological resources of filming activities carried out at Dwejra, Gozo, between September 2010 and November 2010. Independent Consultants, Malta, 28 pp. [Unpublished report].

Borg J. A. & Schembri P. J., 2010. An assessment of the impact of filming activities at Dwejra, Gozo, on marine ecological resources. Independent Consultants, Malta, 24 pp. [Unpublished report].

2 Summaries for individual reports

2.1 Report of assessment of the impact on assets pertaining to geology, geomorphology and palaeontology, landscape and visual scene, and protected area integrity

Field surveys were carried out to assess geology, geomorphology and palaeontology, landscape and visual scene, and protected area integrity, within the AoD.

Impacts on geology, geomorphology and palaeontology, and landscape and visual scene were assessed through: (i) a review of baseline data relating to assets within the area and to the management framework; (ii) field surveys, carried out both whilst clean-up activities were underway and upon their completion; and (iii) a review of documentation relating to the activities carried out. Impacts were assessed in terms of the following criteria: (i) Duration (temporary/permanent); extent (in relation to site coverage and surroundings and associated features); nature (adverse/beneficial; direct/indirect); reversibility; sensitivity of resources to impacts; scope of mitigation/enhancement; and residual impacts. Furthermore, assessment of the magnitude and significance of impact was also carried out, taking into account the aforesaid criteria. For protected area integrity, assessment was made based on the European Commission's methodological guidance for assessment of plans and projects in Natura 2000 sites (*Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6 (3) and (4) of the Habitats Directive 92/43/EEC*).

2.1.1 Palaeontology

The results of the field surveys in the AoD pertaining to the state of fossils and ichnofossils, with respect to signs of evident damage that may have occurred during or as a result of (i) the deposition of sediment, (ii) filming activities and/or (iii) subsequent clean-up operations., indicated that the AoD harbours many fossil and ichnofossil features of interest, most notably several specimens of the echinoid *Scutella subrotunda* (Leske). Many of these were noted to be highly fragmented, but a few complete tests were also recorded. The complete aboral surface of a single example of ? *Eupatagus dekonincki* (Wright) was observed. There were also fragmented disarticulated valves of pectenids scattered throughout the area; a few tests of irregular echinoids were also observed in cross-section at the surface. Additionally, there a dense network of ichnofossils of Thalassinoidean burrow infills, transiting upwards into a more reticulate network.

Given that the fossils and ichnofossils in the entire Dwejra area are impacted upon by: (i) continuous trampling by visitors on a regular basis [visitor pressure within the AoD is particularly heavy as this part of the site is directly accessible from the parking lot; until recently (2005), the area was also

traversed by dive-support vehicles]; and (ii) known instances of fossil theft (involving hewing out fossils from the rock face) from this area, it was concluded that the present assessment cannot definitively link any observed damage to the specific activities carried out in connection with the filming of *Game of Thrones*. However, the assessment does confirm that some of the damage observed is of recent origin, as evidenced from freshly fractured fossils and damaged ichnofossils of Thalassinoidean burrow infills beneath seemingly fresh heavy vehicle tyre tracks. This overall conclusion is strengthened by data collected using quadratting techniques in the AoD itself, as well as in two reference sites, which indicated that there is damage to fossils and ichnofossils throughout the site (both within and outside the AoD). A higher level of fossil pitting was recorded within the filming site, while there was also evidence of fossil theft from this same area, possibly due to its easy accessibility. It should be noted, however, that damage to fossils and ichnofossils was also observed in parts of the AoD that were not quadratted. Therefore, the records of damage are not exhaustive and do not reflect the total damage to fossils and ichnofossils sustained within the AoD.

In terms of the assessment criteria, the following conclusions were reached:

- **Duration:** Any damage to fossil and ichnofossil features is of a permanent nature.
- **Extent:** The extent of damage to fossils and ichnofossils incorporates the AoD but also extends beyond it. As noted above, whilst not excluding that damage to fossils and ichnofossils resulting from the filming activities (and noting that a higher degree of damage was recorded in the AoD), it is also likely that a range of other threats impact upon fossils and ichnofossils. Thus, there is damage throughout the areas where fossils and ichnofossils occur.
- **Nature:** The observed impacts are of a detrimental nature, and are a direct result of actions taking place on site.
- **Reversibility:** The impacts on fossil and ichnofossils are irreversible.
- **Sensitivity of resources to impacts:** Given the unique heritage value and irreplaceable/non-renewable nature of fossils and ichnofossils, these are considered to be highly sensitive to any type of negative impact.
- **Scope of mitigation/ enhancement:** Given that the damage is of a permanent nature and irreversible, there is no scope for mitigating impacts which have occurred. The only option available is to limit any further damage on site.
- **Residual impacts:** Given that there is no scope for mitigation, the observed impacts are residual.
- **Magnitude:** The magnitude of damage to fossils and ichnofossils within the AoD and in other parts of the Dwejra site is considered to be high. The magnitude of damage caused by the filming events and ancillary activities is difficult to determine with any degree of certainty.
- **Significance:** The significance of damage to fossils and ichnofossils within the AoD and in other parts of the Dwejra site is considered to be high, given the: (i) extent of observed damage, (ii) the sensitivity of the resource to damage, (iii) permanent and irreversible nature of damage, and (iv) in-existent scope for mitigating impacts.

2.1.2 Geology and geomorphology

The results of the field surveys in the AoD pertaining to geology and geomorphology indicate that the area comprises a zone of transition between the Xlendi Member of the Lower Coralline Limestone formation, including several fossil fragments forming part of the *Scutella* bed, and the lowermost beds of the Lower Globigerina Limestone formation. The geomorphology of the AoD is characterized by several karstic lapies. At the micro-scale, karstic features include ridges and pinnacles (positive-surface features), and pits and runnels (negative-surface features).

Direct damage to karstic features was noted within the south-western and western reaches of the AoD, closest to the sea. Within this area, the terrain is more jagged than further east within the AoD. Several rock pinnacles appeared to have been broken off; given the size of broken-off fragments, the damage is likely to have been caused by the use of heavy mechanical machinery. The recent nature of the damage was evident on the basis of the sharpness of rock fractions, and colour distinction between broken-off fragments and the surrounding bedrock. However, notwithstanding that the clean-up operation removed the vast bulk of deposited sediment, the nature of the karstic rock surface made it difficult for all sediment to be removed. For this reason, small sediment fractions are likely to remain entrapped within negative-surface pits for some time, until washed out by rains or moved by aeolian processes.

Apart from the extraneous deposited sediment, other areas of provenance of particulate matter are present in the area. These include sediment from the unpaved car park on the access road to Dwejra, silt and soil eroded from agricultural land upstream, and material from nearby quarry spoil heaps. Some of this sediment may make its way to the AoD.

The AoD slopes in a south-westerly direction at an average angle of 5°. As a result, any remaining sediment fractions within the eastern reaches of the site are likely to be washed down in a seaward south-westerly direction as a result of precipitation events. Such sediment appears to accumulate: (i) within a lower-lying rockpool, which is presently used for salt production, and (ii) within a deep crevice close to the shore (Plates 16, 17 and 18). Fieldwork observations confirm that sediment appears to remain entrapped in these areas, and there seem to be no conduits for channelling sediment from these areas to the sea.

In terms of the assessment criteria, the following conclusions were reached:

- **Duration:** Direct damage to karstic features in terms of broken-off fragments is of a permanent nature. The accumulation of sediment in pits, crevices and rock-pools is of a temporary nature, and such sediment will likely be washed out/displaced by aeolian processes in time.
- **Extent:** The extent of damage is limited to the AoD and immediate surroundings.
- **Nature:** The observed impacts are of a negative nature and a direct result of the activities that were carried out.
- **Reversibility:** The damage to rock features is irreversible, as these cannot be restored to their prior condition. The accumulation of sediment in pits, crevices and rock-pools is reversible in time. The time-frame for the impacts to be reversed is highly dependent on weather conditions, specifically on the occurrence of rainfall events, and/or on the occurrence of strong winds and possibly on the action of waves on the immediate shoreline region.
- **Sensitivity of resources to impacts:** The karstic features in the AoD are highly sensitive to any irreversible damage. The level of sensitivity to the sediment accumulation impacts is low, as such impacts are unlikely to cause lasting damage to any of the geological/geomorphological features in the AoD.
- **Scope of mitigation/ enhancement:** All feasible mitigation measures have already been implemented through clean-up of the site, through which the bulk of deposited sediment was removed. No additional mitigation measures are considered necessary at this stage, as any residual sediment fractions will likely be removed by natural processes in due course.
- **Residual impacts:** Residual impacts concern the damaged karstic features in the south-westerly reaches of the AoD; damage to these features cannot be mitigated.

- **Magnitude:** The magnitude of impacts to geology and geomorphology is considered to be of a medium scale.
- **Significance:** The significance of impacts to geology and geomorphology related to sediment accumulation are considered to be low, as such impacts are temporary and reversible with little lasting damage. The significance of impacts relating to damaged karstic features is considered to be high, given the permanent and irreversible nature of such impacts.

2.1.3 Landscape and visual scene

The results of the field surveys in the AoD pertaining to landscape and visual scene show that the AoD is located within the north-westerly reaches of the Dwejra site, adjacent to the surfaced parking area. Land cover within the AoD comprises bare rock with extensive fossil and ichnofossil beds, together with a very sparse vegetation cover represented by a few plants of *Arthrocnemum macrostachyum* and *Inula crithmoides*. Adjacent areas contain elements of the Aerohaline community, including *Crithmum maritimum*, the endemic *Limonium melitense*, the endemic *Anthemis urvilleana*, and *Inula crithmoides*, among others; a single specimen of *Helichrysum melitense* was also noted close to the AoD. Overall, the results of the assessment indicate that impact of the deposition of extraneous sediment at Dwejra is limited, given: (i) that the spatial extent of the impact was contained and that this impact is absorbed within the large-scale and expansive landscape context, and (ii) that the bulk of deposited sediment was subsequently removed. At the micro-scale, impacts on landscape features are, however, evident within the AoD, relating to (i) damage to karstic features, and (ii) damage to fossils and ichnofossils.

The visual impact of deposition of extraneous sediment is related primarily to the characteristics of the deposited sediment which left behind a reddish residue on the affected rock surface. Conversely, the bedrock in the eastern parts of the AoD is generally yellowish in colour. The composition of the material, which was derived from a variety of sources, was also a factor in its solidification and persistence in the AoD; the sheen of deposited sediment which is likely to persist until it is washed away by rainfall, has thus produced an alteration in the colour characteristics of the AoD.

In terms of the assessment criteria, the following conclusions were reached:

- **Duration:** Visual and landscape impacts are largely temporary in nature; exceptions apply with respect to the permanent damage to geomorphological, and fossil and ichnofossil features.
- **Extent:** The extent of damage is limited to the AoD and immediate surroundings.
- **Nature:** The observed impacts are of a negative nature given the lack of coherence with the site's context, and are a direct result of the activities that were carried out.
- **Reversibility:** Landscape and visual impacts are reversible to a very large extent. The reddish colour alteration of the landscape in the AoD is likely to be reversed following a number of precipitation events which will remove the sheen of deposited sediment. Irreversible landscape impacts relate to the damaged geomorphological, and fossil and ichnofossil features.
- **Sensitivity of resources to impacts:** The landscape of the Dwejra area is highly sensitive to any impacts, given: (i) the presence of several unique features, (ii) the open and expansive views which characterize the area, and (iii) the natural 'feel' of the area (sense of place), related to the relative lack of human impact.

- **Scope of mitigation/ enhancement:** All feasible mitigation measures have already been implemented through the clean-up of the site, through which the bulk of deposited sediment was removed. No additional mitigation measures are considered necessary at this stage, as any residual sediment fractions will likely be removed by natural processes in due course.
- **Residual impacts:** Residual impacts concern the damaged karstic, and fossil and ichnofossil features; damage to these features cannot be mitigated.
- **Magnitude:** The magnitude of impacts to landscape is considered to be of a **low** scale.
- **Significance:** The significance of impacts related to landscape are considered to be **low** given that these are largely temporary and reversible; the permanent damage to karstic, and fossil and ichnofossil features should, however, be noted.

2.1.4 Protected area integrity

In terms of the assessment criteria for protected area integrity, the following conclusions were reached:

Potential to:

Cause delays in progress towards achieving the conservation objectives of the site:	No
Interrupt progress towards achieving the conservation objectives of the site:	No
Disrupt those factors that help to maintain the favourable conditions of the site:	No
Interfere with the balance, distribution and density of key species that are the indicators of the favourable condition of the site:	No
Cause changes to the vital defining aspects (e.g. nutrient balance) that determine how the site functions as a habitat or ecosystem:	No
Change the dynamics of the relationships (between, for example, soil and water or plants and animals) that define the structure and function of the site:	No
Interfere with predicted or expected natural changes to the site (such as water dynamics or chemical composition):	No
Reduce the area of key habitats:	No
Reduce the population of key species:	No
Change the balance between key species:	No
Reduce diversity of the site:	No
Result in disturbance that could affect population size or density or the balance between key species:	No
Result in fragmentation:	No
Result in loss or reduction of key features (e.g. tree cover, tidal exposure, annual flooding, etc.):	No

The authors emphasise that the criteria used for the above assessment are focused almost exclusively on issues of biodiversity. Thus, notwithstanding the results of the assessment which indicate no long-term impact on the integrity of the Natura 2000 site, this finding applies only with reference to habitats. The noted damage to irreplaceable fossil and ichnofossil features (whether such damage was caused by filming and ancillary activities, or by unrelated visitor pressures, or by

both) constitutes a clear threat to the integrity of the site's geological, geomorphological and palaeontological heritage; similarly, the observed damage to karstic features also works against the overall integrity of the protected area.

2.1.5 Other aspects

Impact on salt production

Given the gradient of the AoD (see section 2.1.2 above), sediment is likely to travel in a south-westerly direction, accumulating in a rock-pool in the south-western reaches of the AoD. This rockpool is presently used for salt production. Given that the sheen of sediment in other parts of the AoD is likely to be washed away following rainfall events, and that such sediment will likely continue to accumulate within this rockpool for some time, it is reasonable to expect that impacts on salt production may occur. Since the first harvest (which is, as a rule, discarded) usually takes place in early March, followed by harvests in late summer. The occurrence of negative impacts on salt production would thus be most significant should there be instances of precipitation between the March and late summer harvests. Such impacts on salt production would likely persist until the input of sediment from other reaches of the site into the pool becomes negligible, most likely after a number of precipitation events.

2.1.6 Recommendation

The main recommendation concerning the deposited sediment, from the assessment pertaining to geology, geomorphology and palaeontology, landscape and visual scene, and protected area integrity, is that no further clean-up activities should be carried out on site. The bulk of the sediment has, to date, been removed, and any attempts to remove the fractions which remain are likely to cause further damage to the rock surface and fossil and ichnofossil assets. Furthermore, it is predicted that remaining sediment will likely be removed through the actions of rain/wind within a few seasons.

2.2 Report of assessment on terrestrial ecological resources

Field surveys were carried out in the AoD and an adjacent reference area (RA) to assess the impact of the material deposited in the AoD on terrestrial ecological resources.

The vegetation of the AoD and the RA was investigated through a systematic search for all plants and plant remnants in these areas, through a walkover survey of each area, starting along the perimeter and following an approximately spiral path towards the centre. The survey was repeated four times in the AoD and twice in the RA in order to minimise the probability of omission of any part of either area. Particular attention was paid to geomorphological features, including fissures and hollows, where accumulations of sediment may potentially have provided anchorage, water-retention, nutrient retention and microsymbionts for plants. All plants and plant fragments occurring within each area were recorded. Fauna in the AoD were searched for through a walk-over survey; attention was given to any traces of dead fauna or faunal remains rather than to any motile forms (such as flying insects) since any moving animal on the surface of the sediment is almost certainly to have arrived there subsequent to the deposition and clean-up operations. The periphery of the AoD, its near environs and the RA were systematically searched for fauna paying particular attention to microhabitats where cryptic biota may seek refuge, including in cracks and fissures in the rock, under overhangs, under stones and at the base of vegetation. Samples of sediment from the base of

vegetation within the RA were taken and were later sieved in the laboratory and examined for any burrowing fauna. The biota of adlittoral and supralittoral rockpools in the area between the AoD and the sea was examined by visual inspection and by collecting water and sediment samples, which were later examined in the laboratory, including under magnification.

The extent and intensity of ecological impact arising from deposition of extraneous sediment and the subsequent clean-up operations was assessed by recording visible indications of damage sustained by individual plants or clusters of plants. Such observations were carried out within the AoD, the RA and their near environs in order to place the condition of plants within the AoD into a wider context.

The results indicated that there was no direct evidence that any macroscopic fauna were buried by the deposition of extraneous sediment in the area of operations, although this possibility could not be excluded for small sedentary species that live in crevices and fissures in the rock, under overhangs, under stones, or at base of the vegetation that was buried. Plants along the eastern fringes of the area of deposition were, in places, partially buried by sediment arising from overspill but were still photosynthetic at the time of survey. No macroscopic fauna in the areas receiving overspill sediment from the area of deposition were found to have been impacted. However, vegetation in such areas was found to have a number of animal species associated with it suggesting that the partially buried plants may have had fauna that were negatively impacted by sediment transported or spilled from the area of deposition. At the time of survey, the bottom sediment in rockpools in areas adjacent to the area of deposition did not exhibit any differences from the bottom sediment in rockpools situated well away from the site, suggesting that transport of sediment into the pools through surface runoff was not significant in the long term. Any transported sediment would have been unlikely to reach the sea in large volumes as the intervening rockpools and other depressions act as efficient sediment traps.

Overall, an impact on Habitat 1240, 'vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.', was recorded within the AoD as a direct consequence of the deposition of extraneous sediment. None of the plant and bird species listed in Annex II of Council directive 92/43/EEC (the 'Habitats Directive') for which the Dwejra-Qawra area was designated an SAC were recorded from the AoD or RA during the time of the survey, and it is unlikely that these have been impacted by the deposition of extraneous sediment.

None of the plant species included as 'other Important Species of Flora' in the Standard Data Form for the Dwejra-Qawra SAC, were noted from the AoD at the time of survey, and it was concluded that it is unlikely that any individuals attributable to these species were present in the AoD prior to deposition of extraneous sediment as no characteristic plant remains were noted in possible anchorage sites. Individuals of some of these species were recorded from the RA or the fringes of the AoD but these did not have visible indications of damage. Nonetheless, a small number of Maltese Sea-lavender (*Limonium melitense*) were partially buried by sediment along the path of runoff flowing down from the platform on which the AoD was situated.

None of the animal species included as 'other Important Species of Flora' in the Standard Data Form for the Dwejra-Qawra SAC, were noted from the AoD at the time of survey, and only two, the Maltese Wall Lizard *Podarcis filfolensis maltensis* and Spratt's Top-shell *Trochoidea spratti*, were recorded from the fringes of the AoD and from the RA. Any individuals of *Podarcis filfolensis* that may have been present in the AoD would have been associated with vegetation there; it has already been established that at most, only isolated shrubs were present in the AoD, therefore, if any lizards were present, these would have been single individuals. In any case, the Maltese Wall Lizard is a very active and agile species in daytime so it is very likely that even had any lizards been present, these would have relocated outside the AoD at the start of the dressing operations. The presence of small numbers of Maltese Wall Lizard on the periphery of the AoD suggests that these animals may use the AoD for basking or foraging and would therefore have been impacted through loss of basking and foraging space. However, while this is theoretically possible, given that the lizards are active and range over considerable areas and that the affected area was of limited size, such an impact is

deemed negligible in practical terms. The situation is different for *Trochoidea spratti* since these are sedentary snails that live on vegetation or in fissures in the rock and are not active for long periods of time, and when active do not range widely. Therefore, any populations within the AoD would have been buried under the sediment and are likely to have perished. While no dead shells were found when the AoD was searched, this does not exclude the possibility that such shells were present and were removed with the sediment when the bulk of this was carted away at the beginning of the cleanup operations. The presence of live snails and of shell fragments at the periphery of the AoD and in the RA suggests that this species may have been present and therefore impacted. On the other hand, even if this was the case, the number of affected individuals would have been low given the exposed nature of the site and the paucity of vegetation within the AoD, so this impact is deemed small for the overall population of the species in the general area under consideration.

Overall, it was concluded that the disturbance represented by the deposition of the extraneous sediment has not compromised the integrity of the terrestrial biological communities within the SAC but impacts were localized. As much of the extraneous sediment had been removed at the time of survey, any mitigation measures are concerned with the small-scale accumulations of accessory materials and litter along the fringes of the AoD. It was recommended to remove these materials manually, by a small number of personnel, in order to minimise the effects of trampling on the general area. Particular attention should be paid to the piles of dry vegetation along the eastern margin of the AoD. Removal of this vegetation would minimise the possibility of establishment of any extraneous species that may have been transported with the vegetation. No further removal of residual sediment from the AoD or which has accumulated outside the area as a result of redistribution during the clearance process, is recommended. Such sediment accumulations, while appreciable, are overall small and more damage will be done by any further clearance operations than will be mitigated, given that the area is already subject to accumulating sediment from other sources, that the high exposure to wind and wave action will redistribute loose sediment and dilute its effects (although it will probably not affect consolidated or re-consolidated sediment much), and that most of the impacted biota are species that are adapted to live in conditions where the frequency of disturbance and of catastrophic events is high.

2.3 Report of assessment on marine ecological resources

Field surveys were carried out in the marine area (henceforth Area of Study, AoS) adjacent the AoD to assess the impact of the extraneous sediment on marine ecological resources. Fieldwork consisted of broad-brush surveys of the infralittoral zone in the study area within the 0 m – 45 m depth range using direct observation along transects laid underwater by scientific SCUBA divers. Data on the demersal and pelagic fishes and other fauna present in the study area were collected along the same transects. Observations on the potential presence of sediment accumulations, both from the sea and from land, in the mediolittoral zone were also made.

Assessment of impact was made based on observations of signs of deposited sediment and/or accumulations of sediment on biota and/or benthic habitats that would suggest deposition and/or smothering by extraneous sediment originating from the AoD, and to the presence of turbid conditions in the water column. Special attention was also paid to the overall state of the biotic features within the AoS. Finally, data on the main physical characteristics and on the occurrence and distribution of benthic assemblages and habitats recorded from the present study were compared with those represented in the map for the same area made during the most recent survey (undertaken in the Dwejra-Qawra area in 2002), to assess whether sediment originating from the AOD had affected, in any way, the overall physical and biological characteristics of the marine SAC.

The results of the surveys indicated that (i) there were no accumulations of sediment on the seabed that may have originated from the extraneous material, and the underwater visibility was very good (> 30 m) during all fieldwork sessions, indicating the absence of any suspended material in the water

column at the time of survey; (ii) naturally occurring patches of sediment did not appear to have increased in size as a result of addition of extraneous material; (iii) no burial or smothering of infralittoral benthic biota and habitats or other adverse effects on these biotic features that may have resulted from the extraneous sediment were detected; (iv) a rich demersal and pelagic fish fauna was recorded from the study area, which did not appear to have been affected adversely by any potential introduction of extraneous material to the marine environment. Examination of the mediolittoral zone for the presence of extraneous sediment did not result in any such material being present in this zone.

The results of the surveys and assessment of impact indicated that: (i) Since Habitat type '1120 *Posidonia* beds (*Posidonion oceanicae*)', which is listed in Standard Data Form for the Dwejra-Qawra SAC (MEPA, 2008), is mainly restricted to Dwejra Bay and is not known to occur in the study area, specifically adjacent the AoD, no adverse impact was noted for this habitat; (ii) other habitat types listed in Annex I of Council Directive 92/43/EEC are potentially present in the Dwejra-Qawra marine SAC (Borg et al., 2004), however, none of these were impacted by the extraneous sediment; (iii) of the 17 species that are listed in the Standard Data form for the Dwejra-Qawra SAC (MEPA, 2008), all were recorded from the study area except for the seagrass *Posidonia oceanica* and the Noble Pen Shell *Pinna nobilis* (both these are not known to occur in the study area and are restricted to Dwejra Bay). For the 15 recorded species, none of the respective populations observed in the AOS during the present surveys exhibited any observable indication of adverse effects or damage potentially resulting from the extraneous sediment.

Overall, no adverse impact on the marine environment within the study area was evident and, therefore, the integrity of the marine ecosystem, in particular, the biotic assemblages and habitats present within the Dwejra-Qawra marine SAC, had not been compromised. It was also concluded that it seems unlikely that large volumes of the extraneous sediment had been transported to the marine environment, since the rockpools present on the shore between the area of deposition and the sea appear to have served as sediment traps. Furthermore, given the high exposure of the site to wave action and water movement, any extraneous sediment that may have been introduced to the marine environment would have been transported offshore and dispersed and, if deposited, this is likely to have been in places where natural accumulations of sediment are already present.

Given that the results of the present study indicated that no extraneous sediment was present in detectable quantities on the seabed or in suspension within the AoS, no mitigation measures concerning the marine environment are being proposed.

3 Summary of conclusions

- The findings from the assessment of impact on palaeontology indicate that, given that the fossils and ichnofossils in the entire Dwejra area are impacted upon by: (i) continuous trampling by visitors on a regular basis [visitor pressure within the AoD is particularly heavy as this part of the site is directly accessible from the parking lot; until recently (2005), the area was also traversed by dive-support vehicles]; and (ii) known instances of fossil theft (involving hewing out fossils from the rock face) from this area, the present assessment cannot definitively link any observed damage to the specific activities carried out in connection with the filming of *Game of Thrones*. However, some of the damage observed is of recent origin, as evidenced from freshly fractured fossils and damaged ichnofossils of thalassinoidean burrow infills beneath seemingly fresh heavy vehicle tyre tracks.
- The findings from the assessment of impact on geology and geomorphology indicate direct damage to karstic features within the south-western and western reaches of the AoD, closest to the sea. Within this area, the terrain is more jagged than that further east within the AoD.

Several rock pinnacles appeared to have been broken off; given the size of broken-off fragments, the damage is likely to have been caused by the use of heavy mechanical machinery. However, notwithstanding that the clean-up operation removed the vast bulk of deposited sediment, the nature of the karstic rock surface made it difficult for all sediment to be removed. For this reason, small sediment fractions are likely to remain entrapped within negative-surface pits for some time, until washed out by rains or moved by aeolian processes. It was also concluded that, apart from the extraneous deposited sediment, other areas of provenance of particulate matter are present in the area. These include sediment from the unpaved car park on the access road to Dwejra, silt and soil eroded from agricultural land upstream, and material from nearby quarry spoil heaps. Some of this sediment may make its way to the AoD. As the AoD slopes in a south-westerly direction, at an average angle of 5°, any remaining sediment fractions within the eastern reaches of the site are likely to be washed down in a south-westerly seaward direction as a result of precipitation events. Such sediment appears to accumulate (i) within a lower-lying rockpool which is presently used for salt production, and (ii) within a deep crevice close to the shore (Plates 16, 17 and 18). Fieldwork observations confirm that sediment appears to remain entrapped in these areas, and there appear to be no conduits for channelling sediment from these areas to the sea.

- The findings from the assessment of impact on landscape and visual scene indicate that the impact of extraneous sediment at Dwejra is limited, given that: (i) the spatial extent of the impact was contained and that this impact is absorbed within the large-scale and expansive landscape context, and (ii) the bulk of deposited sediment was subsequently removed. At the micro-scale, impacts on landscape features are, however, evident within the AoD; these relate to: (i) damage to karstic features, and (ii) damage to fossils and ichnofossils. It was also concluded that the visual impact is related primarily to the characteristics of the deposited sediment which left behind a reddish residue on the affected rock surface. Accordingly, the bedrock in the eastern parts of the AoD is generally yellowish in colour. The composition of the deposited material, which was derived from a variety of sources, was also a factor in its solidification and persistence in the AoD; the sheen of deposited sediment which is likely to persist until it is washed away by rainfall, has thus produced an alteration in the colour characteristics of the AoD.
- The findings from the assessment of impact on the protected area integrity indicate that there are no long-term impacts, however, this finding applies only with reference to habitats. Thus, notwithstanding, the noted damage to irreplaceable fossil and ichnofossil features (whether such damage was caused by filming and ancillary activities, or by unrelated visitor pressures, or by both) constitutes a clear threat to the integrity of the site's geological, geomorphological and palaeontological heritage; similarly, the observed damage to karstic features also disrupt the overall integrity of the protected area.
- Given the seaward sloping gradient of the AoD, sediment is likely to travel in a south-westerly direction, accumulating in a rock-pool in the south-western reaches of the AoD. This rockpool is presently used for salt production. Given that the sheen of sediment in other parts of the AoD is likely to be washed away following rainfall events, and that such sediment will likely continue to accumulate within this rockpool for some time, it is reasonable to expect that impacts on salt production may occur. Since the first harvest (which is, as a rule, discarded) usually takes place in early March, followed by harvests in late summer, the occurrence of negative impacts on salt production would thus be most significant should there be instances of precipitation between the March and late summer harvests. Such impacts on salt production would likely persist until the input of sediment from other reaches of the site into the pool becomes negligible, most likely after a number of precipitation events.

- The findings from assessment of impact on terrestrial ecology indicate that there was no direct evidence that any macroscopic fauna were buried by the deposition of extraneous sediment in the area of operations, although this possibility could not be excluded for small sedentary species that live in crevices and fissures in the rock, under overhangs, under stones, or at base of the vegetation that was buried. Plants along the eastern fringes of the area of deposition were, in places, partially buried by sediment arising from overspill but were still photosynthetic at the time of survey. No macroscopic fauna in the areas receiving overspill sediment from the area of deposition were found to have been impacted. However, vegetation in such areas was found to have a number of animal species associated with it suggesting that the partially buried plants may have had fauna that were negatively impacted by sediment transported or spilled from the area of deposition. At the time of survey, the bottom sediment in rockpools in areas adjacent to the area of deposition did not exhibit any differences from the bottom sediment in rockpools situated well away from the site, suggesting that transport of sediment into the pools through surface runoff was not significant in the long term. Any transported sediment would have been unlikely to reach the sea in large volumes as the intervening rockpools and other depressions act as efficient sediment traps. Overall, the disturbance represented by the deposition of sediment has not compromised the integrity of the biological communities within the SAC, but impacts were localized.
- The findings from assessment of impact on marine ecology indicate that (i) there were no accumulations of sediment on the seabed that may have originated from the extraneous material, and the underwater visibility was very good (> 30 m) during all fieldwork sessions, indicating the absence of any suspended material in the water column at the time of survey; (ii) naturally occurring patches of sediment did not appear to have increased in size as a result of addition of extraneous material; (iii) no burial or smothering of infralittoral benthic biota and habitats or other adverse effects on these biotic features that may have resulted from the extraneous sediment were detected; (iv) a rich demersal and pelagic fish fauna was recorded from the study area, which did not appear to have been affected adversely by any potential introduction of extraneous material to the marine environment. Examination of the mediolittoral zone for the presence of extraneous sediment did not result in any such material being present in this zone. Overall, no adverse impact on the marine environment within the study area was evident and, therefore, the integrity of the marine ecosystem, in particular, the biotic assemblages and habitats present within the Dwejra-Qawra marine SAC, had not been compromised. It seems unlikely that large volumes of the extraneous sediment had been transported to the marine environment since the rockpools present on the shore between the area of deposition and the sea appear to have served as sediment traps. Furthermore, given the high exposure of the site to wave action and water movement, any extraneous sediment that may have been introduced to the marine environment would have been transported offshore and dispersed and, if deposited, this is likely to have been in places where natural accumulations of sediment are already present.