Flood Risk Assessment

for a house site to the South East of Orchard House,

Spey Street, Garmouth, Moray

Planning Application 14/01773/APP

Contents

1.0 Introduction

This assessment is in respect of a site for a proposed house located within the settlement boundary of the village of Garmouth, lying to the South East of Orchard House, Spey Street and adjacent to the Garmouth and Kingston Golf Club course, currently with vehicular access from Mill Lane which continues along the edge of the site as a pedestrian route upwards to the centre of the village. The OS Grid Reference for the site is Northing 864460 Easting 334094.

The immediate environs of the proposed house site consist of contemporary and historical private and public properties. The immediately neighbouring property to the location of the proposed house is a three storey urban townhouse.

The site is currently open land and was formerly part of a commercial farm with the location of the house being used as a stackyard but historically the point of access now proposed to the development site served cottages, a store and a multi-storey corff house used for processing fish, accommodating workers, and as an office for a sawmilling and boatbuilding company.

SEPA's indicative river and coastal flooding map shows the site to lie at the edge of the fluvial functional flood plain with the actual footprint of the proposed dwelling lying to the west of the designation which SEPA confirms they found upon when scrutinising planning applications.

At a meeting on the 11th July, 2014 with Rebecca Raine of SEPA and Graham Dunlop of MFRM it was agreed that the part of the site which was within the functional flood plain should be classed as a "medium risk" area. I.e. not low and not high which, by reference to SPP263, places the risk of flooding at 1 in 200 years.

2.0 Legislative Framework

Scottish Planning Policy (SPP) – Flooding and Drainage along with Planning Advice Note 69 (PAN69) provide guidance to both the controlling authorities and prospective developers for responsible, sustainable development on the functional flood plain. The SPP states that any new development should not materially increase the probability of flooding elsewhere, add to the area of land which requires protection by flood protection measures or affect the ability of the functional flood plain to attenuate the effects of flooding by storing water. It should not interfere detrimentally with the flow of water in the flood plain nor compromise major options for future river management. In line with the SPP all new development needs to take account of the 1 in 200 year return period including an allowance for climate change which we understand SEPA's current recommendations are to consider an increase to peak discharges of 20% to allow for future climate change.

Scottish Planning Policy

SPP260

Reference has been made to the flood assessment maps prepared by SEPA but despite it being a stipulation within the current 2008 Local Plan, Moray Council have not undertaken the preparation of a Flood Scheme for Garmouth as stated.

SPP261

Storage capacity on site will be improved by the development. The current 2008 Local Plan identifies the requirement to prepare a Flood Scheme for Garmouth but to date Moray Council have not undertaken this.

SPP262

This land offers potential for passive storage of flood water and this capability will not be impeded by the proposed amphibious structure

SPP263

Part of the site is identified as being of medium risk and this Flood Risk Assessment has been prepared to comply with the requirement for such a document "at the upper end of the probability range".

A water resistant structural and construction arrangement will be adopted utilising a buoyant impervious floating structural deck and conventional lightweight watertight domestic house construction above that.

The site is confirmed as being within the boundaries of a built up settlement, adjacent to an urban conservation area with the immediately adjacent buildings being of two and

three storey stature. In any event, the building will be designed and constructed to be operational during flooding and not impede water flow.
Water resistant materials and construction will be utilized within an amphibious construction allowing the building to respond to its surrounding environment by rising and falling to be continuously 1metre above surrounding ground or water levels.
Clarifications from Scottish Government indicate that such a structural arrangement can be approved by the local authority subject to their satisfaction of its structural integrity and in this case the applicant has consulted with a firm of Chartered Engineers who confirm that an appropriate design can be prepared to satisfy all the identified aquatic characteristics of the site.
The responsiveness of the proposed building to rainfall events of occurrence greater than 1 in 200 years satisfies the need for the superstructure of the proposed building to be free and independent of surface water flooding.
600m^3 of additional surface water storage with controlled throttled discharge will be provided making the site capable of relieving rainfall run off from adjacent areas.

SPP 264

The site is generally quite level with the area where the proposed house footprint is located having an average level of 4.400 AOD with a general rising to the west and north west to 4.775 AOD. The west and south westerly boundaries of the site are the edges of a raised escarpment and to the north there is a walled lane which rises up to levels above 10 metres AOD.
The design and use of the proposed development is for an amphibious house providing accommodation for one family.
The size of the area likely to flood is illustrated in accordance with the information from the SEPA flood map.
The depth of flood water averages 350mm with a flow rate of 2m/sec and a north to north east flow path to the east side of the site with the inundation extending to approximately 1 hour either side of high tide level during a flood event on the river.
There is no risk of wave action as this is not a coastal site.
The Council have undertaken to "pursue the preparation of a Flood Scheme for Garmouth under the terms of the Flood Prevention (Scotland) Act 1961 as amended". Moray Council have not undertaken this to date.
The effects of climate change have been taken into account in the design of an environmentally responsive structure always allowing a 1 metre free height above any surrounding ground or water levels.
The site is only affected by surface water run-off from adjoining land during a flooding event.

The location of an existing field drain is known and noted on the application drawings as are the locations of proposed culverts to assist in access to the site as well as protecting an adjoining proprietor.
There will be no loss of storage capacity on site and indeed it will be the opposite with the addition of 600m^3.
There will be no cross boundary effects on adjacent local authorities.
A dry pedestrian access to the proposed dwelling will be provided via the adjoining Upper Mill Lane which is not located within the functional flood plain as defined by SEPA.
Apart from the access driveway and parking areas, the only landscaping work that will be undertaken to the site will be to provide additional flood storage capacity in the new swales.

SPP265

The access driveway will run with the existing ground levels and there will be no requirement for land raising in the context of the proposed dwelling as it can rise and fall responsively without permanent upmaking. An additional 600m^3 of auxiliary rather than compensatory storage will be provided.

SPP 266

This Flood risk Assessment is prepared in response to Scottish Planning Policies and SEPA's Flood Risk Maps.

SPP267

Scottish Water have confirmed that there is capacity for a foul water connection from this development and surface water arising from the roof structure will be accommodated and attenuated by virtue of the two proposed swales providing an additional 600m^3 of storage for the application site and the assistance of surrounding properties.

SPP268

The provision of two swales with a combined capacity of 600m^3 and featuring throttled discharges to the existing boundary water course will provide a satisfactory SUDS solution for the long term maintenance of the location.

3.0 Historical Flooding

The haugh land and golf course of Lower Garmouth to the east of the site has a history of regular flooding from the River Spey and its attendant tributary watercourses. SEPA have historical records of flooding relating to the area in question from 1892, 1934, 1990 and 2010. The applicant has experiences of flooding affecting Queenshaugh in 1993 , 1995 and regularly thereafter as a result of works undertaken by the riparian proprietors to the Lower stretches of the River Spey to the north of Byres Farm.

The impact of the flood of 1990 on the land immediately adjacent to the east of the site, predating the current landscaping and tree planting by Garmouth and Kingston Golf Club, was reported upon by the Scottish Agricultural College and a copy of the erosion survey map is appended, from which it can be seen that there was no topsoil erosion of the then ploughed field under the footprint location of the proposed dwelling. Similarly, the Grampian Regional Council Water Services report of January 1995 prepared by Messrs Babtie Shaw and Morton relative to the River Spey flooding at Garmouth in 1993 shows the main flow paths of the river in spate flowing to the east of the site. The extracted plan from the report shows the influence of the flood plain features such as the railway embankment with its two openings at Queenshaugh, the Black Burn and the bridge to the golf course. It should be noted that the report indicates flow velocities of 0.6 cumecs at the village hall in the 1993 flood which recorded a peak flow of 690 cumecs at the nearest gauging station at Boat O' Brig which supports the observation that the application site is not a mainstream flood flow zone.

There is a difference between active flood water and seepage flood water with the former being aggressive and the latter sedentary. Indeed surface water accumulations can affect part of the application side outwith the designated functional flood plain as shallow over burden or simply puddling of static water. The investigation and report mapping by the SAC in 1990 is the only information which is available based upon scientific recording that illustrates and confirms the impact of the flood water flows in the locality. The mapping identifies that there was no erosion over the footprint of the proposed house location despite there having been significant damage elsewhere in the surrounding haugh land which was freshly ploughed as was the site at the time. Indeed, it's to be noted that the westerly limits of the erosion align with the westerly limits of the functional flood plain as shown on SEPA's flood map.

Subsequent to these reports of the 1990s, it's unfortunate that very little of the recommendations were taken up by the riparian proprietors and the local authority however the Golf Club have improved the flows of the Black Burn by altering the

construction of their bridges over the water course thereby reducing the degree of overtopping in flood events. The cross sectional area of the apertures of the two footbridges and the increased channel section of the stream are somewhat less than recommended by Babtie Shaw & Morton but nevertheless will have contributed positively to the flood alleviation of the area.

The term 1 in 200 year flood risk return event relates to a desktop theoretical calculation however we are fortunate in having a physical recording of the worst spate ever in the area of 1829 which sets a level of 5.876m at a point only 1km distant rather than the nearest monitoring station at Boat O' Brig which is 13km away and has only been recording river levels for 60 years. The transposition of this level to the application site would result in an overspill water depth of 1.5m which would be half as high again as the existing field fence post heights which nobody can recall having been submerged during the 50 years family ownership of the application site.

At this junction its worth noting that the location of the proposed house on the application site acts as a flood water reservoir generally for one hour either side of high tide and that the depth of water does not swamp the grass or overtop wellingtons.

4.0 Summary of Quantifiable Sources of Flooding

There is a potential risk of flooding from the River Spey and it's tributary, the Black Burn, both sourcing from existing access openings in the former railway embankment 250metres to the south of the footprint of the proposed house on the application site.
The velocity and volume of water sourcing from these two apertures has been calculated in a flood event as being between 14 and 27 m^3/sec by Babtie Shaw & Morton on behalf of Grampian Regional Council's Water Services when the full flood flow of the River Spey was gauged and recorded at the Boat O' Brig measuring station as being 690 m^3/sec.

The two exit routes for flooding to the north of the application site are down Spey Street and the Black Burn which were similarly assessed by Messrs Babtie Shaw & Morton as having flow characteristics of between 0.6 and 10m^3/sec although this has been improved of late by works to the Black Burn by the golf course bringing the estimated flow rates up to 15m^3/sec at a velocity of 2m/sec when taking into account the roughness factors of the terrain.

The frequency of flooding on the Garmouth & Kingston Golf Course has increased over the last seven years as a direct result of the River Spey's aggressive erosion downstream of Essil instigated by intervention works by the Crown Estate upstream of Essil.

The worst recorded flood event affecting the area was in 1829 when the river at Tugnet rose to 5.876 AOD and at Garmouth to 4.900 AOD. This represents a verified 1 in 185 year flooding event.

The existing ground levels at the footprint of the proposed dwelling house on the application site range from 4.400 to 4.775 AOD.

When the River Spey is in spate, flooding on the adjacent golf course is exacerbated for a period of one hour either side of high tide when additional storage can be required on part of the application site where the depth generally does not exceed 350mm.

5.0 Investigation of the Implications of Temporary Flooding on the Proposed House Footprint of the Application Site

1. Risk of Personal Injury by Rising Flood Water Levels.
   Solution: Locate proposed dwelling footprint outwith the functional flood plain as identified by SEPA. Construct a dwelling with a flotational underbuilding raft platform of one metre height above a ground surface level reinforced concrete slab sill and restrained by 300mm diameter galvanised steel concrete filled pile casings bearing on and socketed into old metamorphic sandstone substrata to resist structural movement and enable a free uniform vertical rise and fall within the restrained area by virtue of engineered structural steel slip collars overfitting the afore mentioned steel piles and attached to the aforementioned raft platform. Thereby the platform can rise and fall in accordance with Archimedes principles to be able to continuously address whatever level of flood inundation may affect the location. The incorporation of an automatic advance warning float trigger switch with an alarm indicator in the dwelling will provide a warning of potential flooding and the activation of the automatic reactive system. A barrier free, wheelchair friendly walkway from the family entrance of the dwelling can hinge and slide to take cognisance of the variable levels of the house but within a range of wheelchair accessible gradients so as to provide a dry escape route above storm water levels to the elevated section of Mill Lane which ascends the backlying escarpment up to the centre of the village.

2. Risk of Deflecting Rising Surface Water Volumes onto other Properties.
   Solution – Enable the proposed dwelling to rise and fall with the advent of onsite flooding such that there would be no diminishment of flood water storage capacity and by the excavation and provision of two swales, a small one to the south and a large one to the north of the site, approximately 600m^3 of additional storm water storage will be provided to assist and improve the existing local situation

3. Risk of Building or Building Services being damaged to the Detriment of Neighbours and Community.
   Solution: The application site can support a gravitational foul water connection to the public sewer which has been supported by Scottish Water. This means that there would be no need for a septic tank with all its attendant flood leaching issues and that foul sewage can be handled by a sealed system.

Rainwater roof drainage can be attenuated in the aforementioned swales so as to provide sustainable urban drainage.

Mains water and electricity will be supplied to the site underground thereby negating any environmental problems.
Services connections from the rise and fall amphibious house to a base reference point will be flexible to accommodate whatever temporary changes in floor level may be encountered.

6.0 Addressing Scottish Government Regulatory Requirements.

Scottish Planning Policies (SPPs) are conceived and enacted in terms of current, preceding and anticipated circumstances. They are regularly revised, reflecting constant changes affecting the world, Scotland, and our locality. The speed with which developing technology is progressing means that quite often legislative controls can be incompatible with environmentally beneficial innovation. The possible occurrence of such anomalies is recognised however, and there are regulatory opportunities to enable "alternative technical solutions" to be approved by delegated authorities.

Contact with Scottish Government at Senior Planner level of the Directorate for Local Government and Communities has confirmed that there is scope for Moray Council to consider and potentially approve non-conventional design solutions to building in areas of flood risk. The advice is that whilst "SPP paragraph 263 states that generally elevated buildings etc are unlikely to be acceptable. This does not necessarily mean therefore that stilted construction would be unacceptable in every circumstance. The inclusion of the reference to stilts comes from a concern over the ability of such a construction to withstand flood events. There is recognition however that within this general reference there may be construction techniques that a planning authority may find acceptable." This response from Edinburgh was in relation to the previous design submission which incorporated the concept of a building with a fixed floor level supported in part on columns and interlinked beams. The current application has developed from that adding the amphibious concept to the design such that the "stilts" would restrain rather than support the house superstructure which could be free to rise and fall in response to any flood event from 20th/21st Century recordings and back two centuries (a real 1 in 200 year event) to the 1829 Muckle Spate recorded level plus whatever freeboard allowance SEPA desire and always maintaining one metre clearance between house floor level and ground or flood water level.

Flood Risk Assessments came into being to assess the impact of potentially variable rising flood water levels upon static structures with fixed floor levels. This design however proposes infinitely variable floor levels to respond to variable flood water levels without displacing any water from the site and keeping the house occupants safe in a familiar comfortable environment being informed/warned by automatic monitors as to the external environment status and continuously accessing all public utilities via

flexible services connections. Bearing in mind that most site overwash has been less than 350mm deep and of less than 3 hours in duration.

The only residual risk is the structural capabilities of the stilts, as referred to by the S.G. and Fairhurst, Consulting Engineers, have confirmed that the concept of restraint is viable using casing columns which can be designed with appropriate ground anchorage to withstand the effects of any anticipated flood event. The flotation deck would be designed by the Dutch company Dura Vermeer who have designed and built over 30 similar dwellings.

7.0 **Discussion.**

The Application site has been assessed against a 1 in 200 year return period plus climate change event which is the SPP's recommended minimum standard of protection applied to all new development within the functional flood plan of a river such as the Spey even although the location of the actual footprint of the house is not within the functional flood plain. Such an event has a 0.5% chance of occurring or being exceeded in any one year or on an average basis such an event will happen once every 200 years. However, in any given period of 200 years it may not happen at all or may happen several times. Statistical analysis shows that there's a 14% chance of at least one 1 in 200 year return period event occurring in a period of 30 years and a 29.6% chance in a period of 70 years.

Research has established that flooding of the golf course immediately to the east of the proposed house location on the application site has not exceeded a level of 4.600 AOD and that a historic 1 in 185 year even resulted in a level of 4.900 AOD recorded at a distance of 150m from the proposed house location on the applicant site and 5.876 AOD at a distance of 1km north of the site.

Velocities and volumes of water assessed independently as flowing over the adjacent golf course during major flood events of the 1990s suggest that the speeds are in the region of 2m/sec with the approaching flows ranging between 14 and 27m^3/sec exiting at a range of 0.6 to 10m^3/sec which equates to 1.5% of the River Spey main channel flows measured at the same time. These statistics have been considered by Messrs Fairhurst, Chartered Engineers, on behalf of the applicant, who readily confirm that there would be no difficulties in designing structural columns to provide support and restraint for the proposed amphibious dwelling such as to comply with all the relevant codes of practice and building standards regulations. This degree of safety and competency in addressing the assessed flood risks satisfies the requirements of SPP263 and PAN69 in the context of the proposed amphibious house as described in the application and attached supporting statements.

8.0 Conclusions

The applicant has researched all available information, considered all reasonable scenarios and assembled a comprehensive flood risk assessment containing recorded data rather than modelling predictions for the application site which is located within the designated settlement boundary and immediately adjacent to a building conservation area having a majority of three and two storey urban structures.

Part of the application site has been identified as per the attached plan as being within the functional flood plain as defined by SEPA but the actual footprint of the proposed house location is not.

The Flood Risk Assessment confirms the source of flooding (River Spey); the direction of flood water flow (from the apertures in the old railway embankment 200m south of the site); the frequency of flooding (currently up to 3 times per annum); the flow path of flood water adjacent to the site (north to north east per SAC and GRC investigations); the average velocity of water within the adjacent flowpath (2m/sec); the volumes of water in the adjacent floodpath (up to $27m^3$/sec); the average level of floodwater in recent events at the site boundary (4.600 AOD) and the recorded near 1 in 200 year flood event levels (4.900 AOD at 0.1 of a kilometre and 5.876 at 1 km from the site in 1829).

Taking cognisance of all this information in the context of potential risks to occupiers of the proposed house, surrounding proprietors and their properties plus the natural aquatic and terra firma environments, this risk assessment illustrates that an amphibious house satisfies the relevant criteria of Scottish Planning Policies bearing in mind the guidance given specifically by Scottish Government with regards to the suitability of purpose designed elevated structures. In this particular Planning Application, Messrs Fairhursts, Consulting Engineers, have confirmed that it will be possible to design appropriate means of structural support and restraint for an amphibious house to address all the identified flooding risks in this report.

Existing legislative constraints are incompatible with the innovative design proposals currently submitted for an environmentally responsively engineered building which

maintains the safety and security of its occupants more effectively than any of its urban neighbours.

The Planning Application proposes a building which is unashamedly contemporary and absolutely responsible offering a positive design philosophy to solve the misery endured by so many people who have flood intolerant buildings to live and work in.

9.0 Appendices

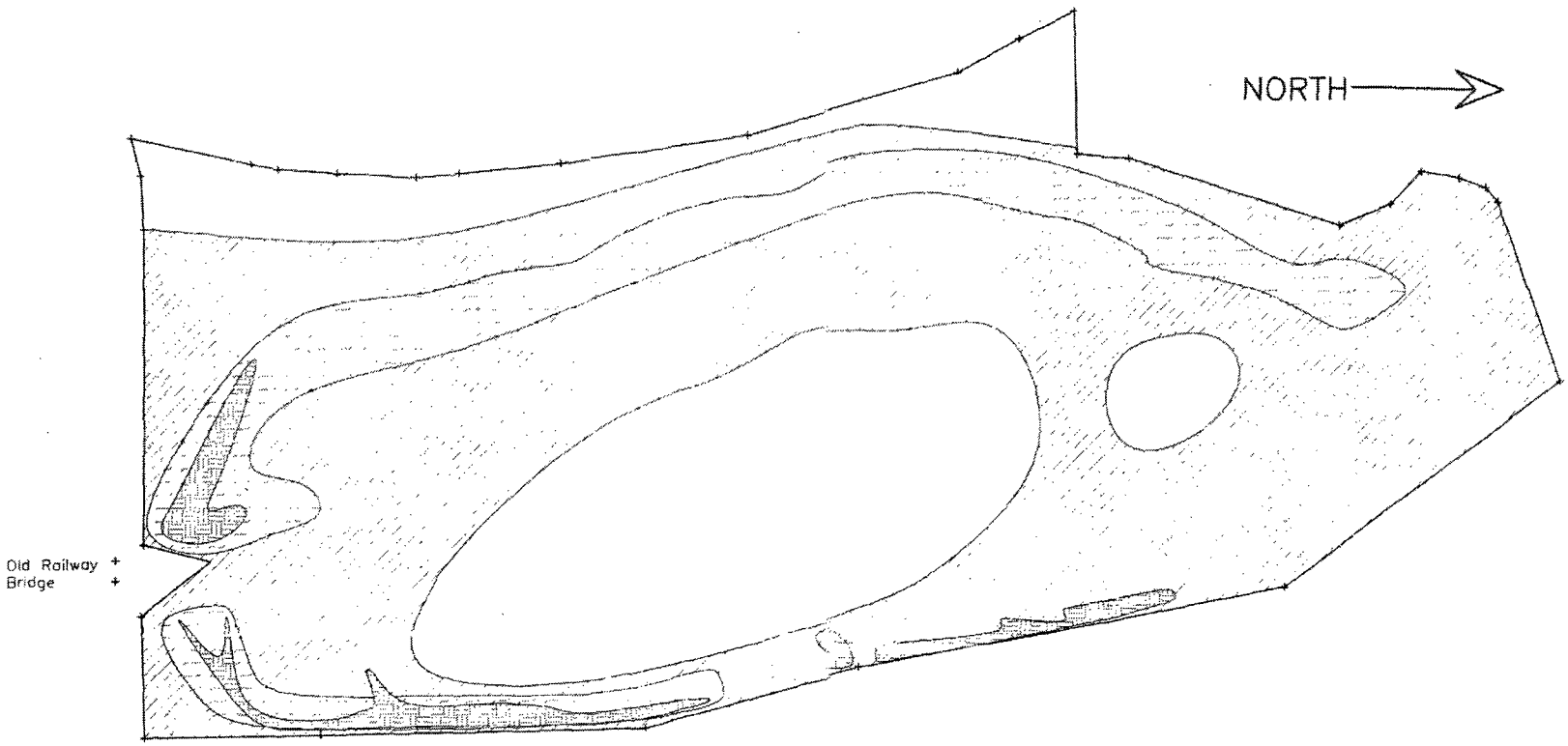
1. Map of erosion categories at Queenshaugh, Garmouth 1990 by SAC

2. Map of existing flood regime at Lower Garmouth 1994 by GRC

3. Map showing application site and extent of SEPA functional flood plain 2014 by Future Plans Ltd

4. Photograph of flooding on site on 18th May 2014 (not 2025) showing "ambient water"

5. Article on "Flood Proof Architecture by Johan van der Pol of Dura Vermeer



LEGEND

Topsoil Erosion Categories

- None
- Slight
- Moderate
- Severe

FIGURE 3

CENTRE FOR RURAL BUILDING
The Scottish Agricultural College
Craibstone Bucksburn Aberdeen
AB2 9TR Tel: (0224) 713741

Erosion categories

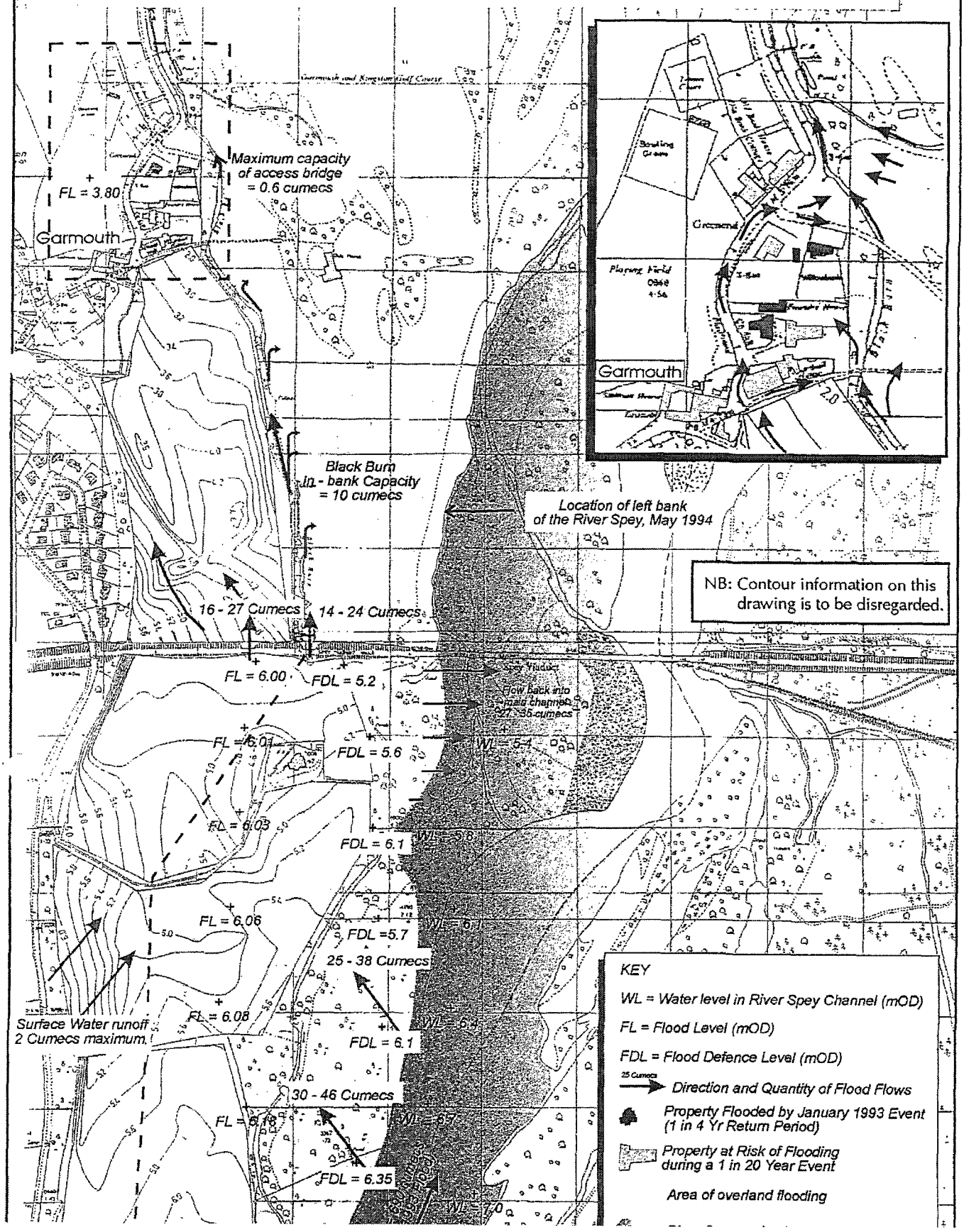
at Queenshaugh, Garmouth

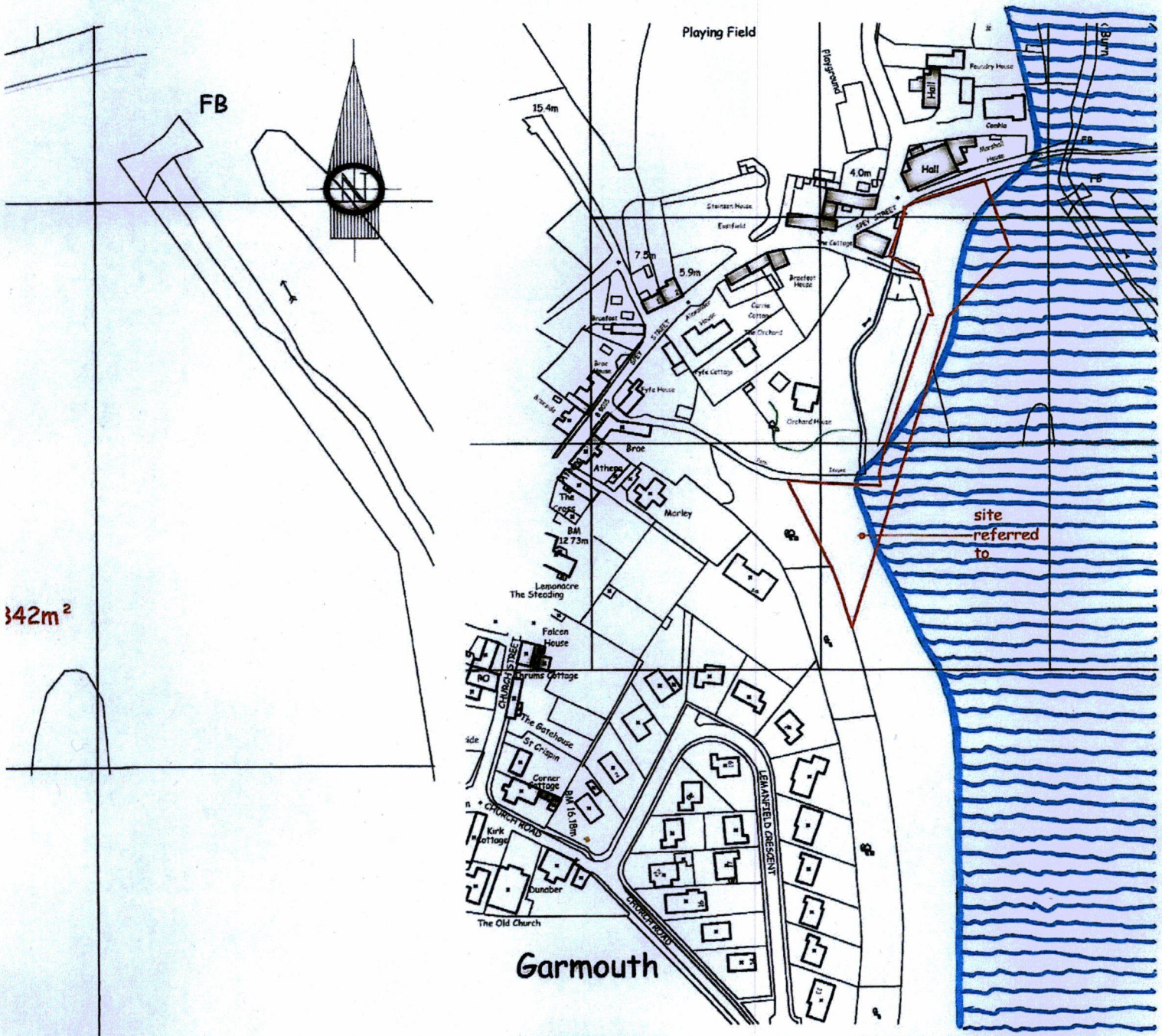
SCALE 1: 1000

DATE 9/5/1990

Grampian Regional Council - Water Services Department

Figure 4 - Summary of Existing Flood Regime





location plan

scale 1:2500

Rev a. House and site revised - 10th September 2014

futureplans

Proposed single storey dwelling, formation of access driveway and associated landscaping works on a site to the south and east of Orchard House, Mill Lane, Garmouth.
for Mr Cyril Smith


SITE
18/05/2025

Flood proof architecture

Concepts and constructive solutions to adapt to rising water levels

Johan van der Pol *(Dura Vermeer, the Netherlands)*

Introduction

Soil compaction and subsidence, urbanisation and climate change increase the vulnerability of (urban) areas to floods. The government is going to invest heavily in the necessary knowledge development, to be able to face climate change.

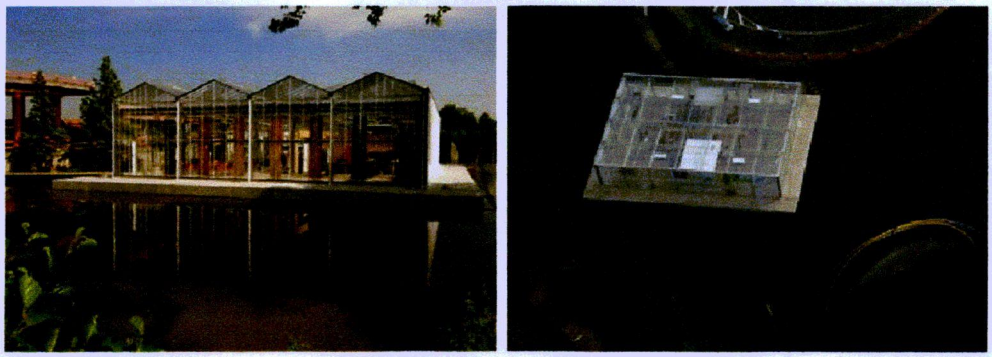
For this task, the building trade can and should make a crucial contribution with new concepts of "building with water'. Especially in highly populated areas, living with water may be a sustainable adaptive solution for future challenges. More and more Dutch designers are getting into 'flood proof' architecture. This has already led to a whole range of concepts and constructive and non-constructive solutions. Noticeable examples of building methods are: floating construction, amphibious construction, construction on piles, elevated construction, dry- and wet proof construction. Practical examples are floating- and amphibious houses, platform houses, artificial islands or reefs, floating offices and floating greenhouses. These items are the specialism of Dura Vermeer, a construction and development company in the building industry. This article illustrates some of their concepts.

Floating greenhouses

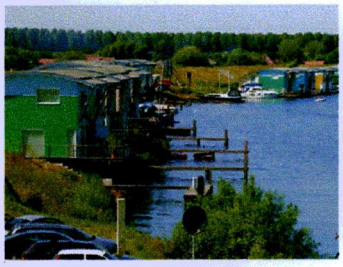
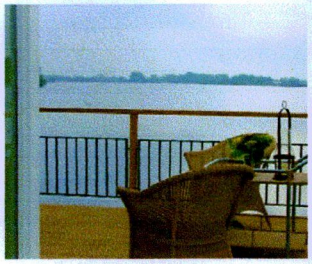
Floating greenhouses offer the opportunity to combine two functions on the same square metre: greenhouse horticulture and water storage. There is an increasing demand for this multiple use of space, because space in The Netherlands is restricted, while the demand for living-, working- and recreational locations is increasing. In the years to come many tens of thousands of hectares will be used for water storage, taking up valuable space. Creating space for water storage is not simple in a densely populated country as the Netherlands. Combining water storage with an economic function may more easily create the necessary space.

The concept of floating greenhouses has been developed from the idea that it contributes to the solution of spatial limitations that arise from the redevelopment of greenhouses and will create space/ room for water storage.

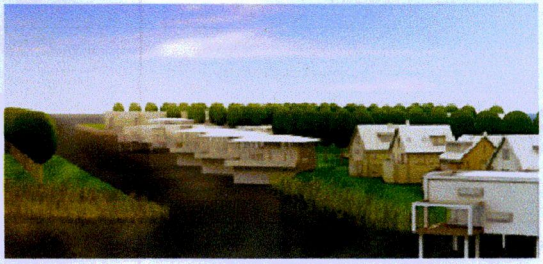
A pilot project for a floating greenhouse is to be realised in the province of South-Holland. The lowest point of The Netherlands is situated in this area: 6,76 metre below NAP (NAP = about average sea level). The idea is to plan an area where a pilot project floating greenhouse can be realised on a commercial basis. The pilot will be an example of a sustainable development of glasshouses combined with water storage. Apart from the development of a floating greenhouse, the business case also comprises a research programme covering the environmental effects. A public-private partnership has been working on the business case for two greenhouse growers since 2005. In 2012 we hope to finally celebrate the opening of the five hectares floating Greenhouse: the Floating Roses.



***First - built floating greenhouse in the world** - Demonstration version, municipality of Westland (photos: Dura Vermeer).*

Amphibious homes (photos: Dura Vermeer)



Impression of a residential district on water (source: Knowledge Project Bouwen met Water)

Amphibious and floating homes

Unlike the houseboats that line many Dutch canals or the floating villages of Asia, these amphibious homes are being built on solid ground — but they also are designed to float on flood water. They look much like regular houses; the only difference is that when the water rises, they rise.
Each house is made of lightweight wood, and the concrete base is hollow, giving it ship-like buoyancy. With no foundations anchored in the earth, the structure rests on the ground and is fastened to 15-foot-long mooring posts with sliding rings, allowing it to float upwards in times of flood. All the electrical cables, water and sewage flow through flexible pipes inside the mooring piles.

Realisation in Maasbommel

The desire to integrate water management issues in the Netherlands in sustainable spatial planning, has led Dura Vermeer to translate this aim into the development and realisation of 32 amphibious and 14 floating houses in Maasbommel in the Province of Gelderland. The houses are the solution to the demands for living-, working- and recreational space and the need for a sound and sustainable water storage. The location in Maasbommel is just outside the dyke ring in a water recreational area, connected with the river Maas. Recent flood events and the subsequent strengthening of the dykes in the river basin have led to the development of houses by an entirely new concept: houses that will float at high water. In order to enable the houses to move with the fluctuating water level, the houses are fixed on concrete floating platforms with a suspension mechanism. At a low water level, the houses rest upon a foundation of concrete. To keep the houses as light as possible the framework consists of timber. To prevent the houses from floating away at high water they are fixed to flexible moorings, with which tugs can be absorbed. It is expected that once every five years the water level will rise so much (over 70 centimetres) that the houses will indeed float. The houses can cope with a water level difference of up to 5,5 metres. That is above the height of the top of the levee.

Residential district on water

In the framework of expertise development, Dura Vermeer made a design for a residential district on water, applied to a pilot location in the low-lying polder Haarlemmermeer, south west of Amsterdam. In this concept, urban functions are integrated with water retention and storage. The result is an environment that not only respects the water system level, but moreover, creates a high-quality living environment and a net saving on space. To answer questions about the feasibility of a pilot residential district on water, a study is to be carried out. This study will show under what circumstances a residential district on water in the Haarlemmermeer is likely to be successful. Based on this, the parties involved can decide whether they want a pilot residential district on water. The developed expertise on the possibilities to combine water storage and construction will first be applied to the Haarlemmermeer. However, since this expertise is also applicable elsewhere, ideas for other locations can also be submitted.

Conclusions

In recent years, the knowledge and experience in the field of flood proof construction has increased strongly. It is an issue, which is not only relevant to the Netherlands, but has also been taken up by other countries. Some remarkable examples of practical applications have been realised, from which learning points are being shared. These experiences are subsequently used in developing the expertise and concepts further and its translation into daily construction practice. This means that expertise is now available for modelling damage because of flooding, construction concepts have also been elaborated, which are based on a sound financial footing, situation-specific and solutions offered and cost-benefit analyses made.
The concepts of flood proof architecture can be an efficient method for adapting to the potential impacts of climate change.

Websites

www.duravermeerbusinessdevelopment.nl
www.bouwenmetwater.nl
www.drijvendekas.nl
www.floatingroses.nl

English language websites

Flexbase: www.flexbase.eu
Floodprobe-Project: www.floodprobe.eu
Urban flood management, Dordrecht city: www.ufmdordrecht.nl