



PANGAEA

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

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ENVIRONMENTAL PLAN SUMMARY**

TABLE OF CONTENTS

1. GEOPHYSICAL SURVEY SUMMARY SHEET	3
2. LOCATION	3
3. DESCRIPTION OF ACTIVITY	3
4. DESCRIPTION OF THE RECEIVING ENVIRONMENT	5
5. DESCRIPTION OF THE ACTIVITY IN RELATION TO THE ENVIRONMENT	5
5.1 LINE PREPARATION	6
5.2 SELF-CONTAINED CAMP.....	6
5.3 ACQUISITION ACTIVITY	6
6. ENVIRONMENTAL MANAGEMENT APPROACH.....	8
7. CONSULTATION.....	13
8. NOMINATED LIAISON PERSONNEL	14
8.1 SEISMIC SURVEY COMMUNIATION CHART.....	14
8.2 PANGAEA RESOURCES OPERATIONS LIASON PESONNEL.....	14

LIST OF FIGURES

Figure 1: Location map showing 2D line layout with exploration permit boundaries.....	4
Figure 2: Sercel 428 / 408 Components (FDU, LAUL, LAUX)	7
Figure 3: AHV-IV Vibrator onsite in Australia	8

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

1. GEOPHYSICAL SURVEY SUMMARY SHEET

Survey Name:	2013 Hidden Valley Seismic Survey
Survey Type:	2D Vibroseis
Permit(s):	EP-167, EP-168, EP-198
Operator and Titleholder:	Pangaea (NT) Pty Ltd (100%)
Proposed Location: (Regional Coordinates)	Latitude 14° 47' 00"S to 16° 49' 00"S (GDA94) Longitude 133° 15' 00"E to 130° 46' 00"E (GDA94)
General Location:	Katherine, Mataranka, Larrimah, Daly Waters, Dunmarra and Victoria River Downs
Survey Boundary:	Within the borders of EP 167, 168 and 198
Approximate Survey Size:	1,400 line km
Expected Date of Commencement:	01-May-13
Anticipated Duration of Survey:	7 months (all inclusive / weather permitting)

2. LOCATION

The Pangaea NT tenements EP-167, EP-168 and EP-198 are located approximately 500km southeast of Darwin in the Northern Territory (NT). The tenements fall within the Victoria-Daly, Roper & Barkley Shires and the Katherine Municipality.

3. DESCRIPTION OF ACTIVITY

Pangaea in conjunction with specialist contractors are planning to acquire approximately 1,400 kilometres of 2D seismic data across parts of EP-167, EP-168 and EP-198 in the Beetaloo and Victoria-Birrindudu Basins of the Northern Territory commencing May 2013. The survey is expected to be completed in seven months weather permitting.

The field activities will be split between contractors, which will allow a stronger local content while utilizing expertise for line scouting and pointing, line preparation and rehabilitation, and data acquisition. Both line preparation and data acquisition activities will be conducted out of mobile camps so as to maximize mobility, minimize unproductive drive times and improve overall HSE.

All field activities will be conducted under SMP, EMP and ERP plans. Both contractors and sub-contractors will develop their own HSE and operational plans to bridge to Pangaea’s plans and contracts.

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

The 2D lines will be acquired as per the plan shown in Figure 1. The general sequence of acquisition will be starting with EP-167, followed by EP-168 and finishing with EP-198. A total of 23 2D lines will be acquired dependent upon the prevailing weather conditions.

Data acquisition will commence around the Birdum area and Main Camp #1 is located approximately 25 km south of Larrimah and 16 km west of Maryfield at the following coordinates: Latitude 15° 49' 17.7"S and Longitude 133° 15' 03.4"E (GDA94) or Easting 312,675.9 mE and Northing 8,250,020.78 mN (MGA94, Zone 53S). Subsequent camp locations will be determined depending on the acquisition progress, operations requirements and convenience (from scouting and surveying the area). The NT DME will be notified after appropriate camp locations have been identified.

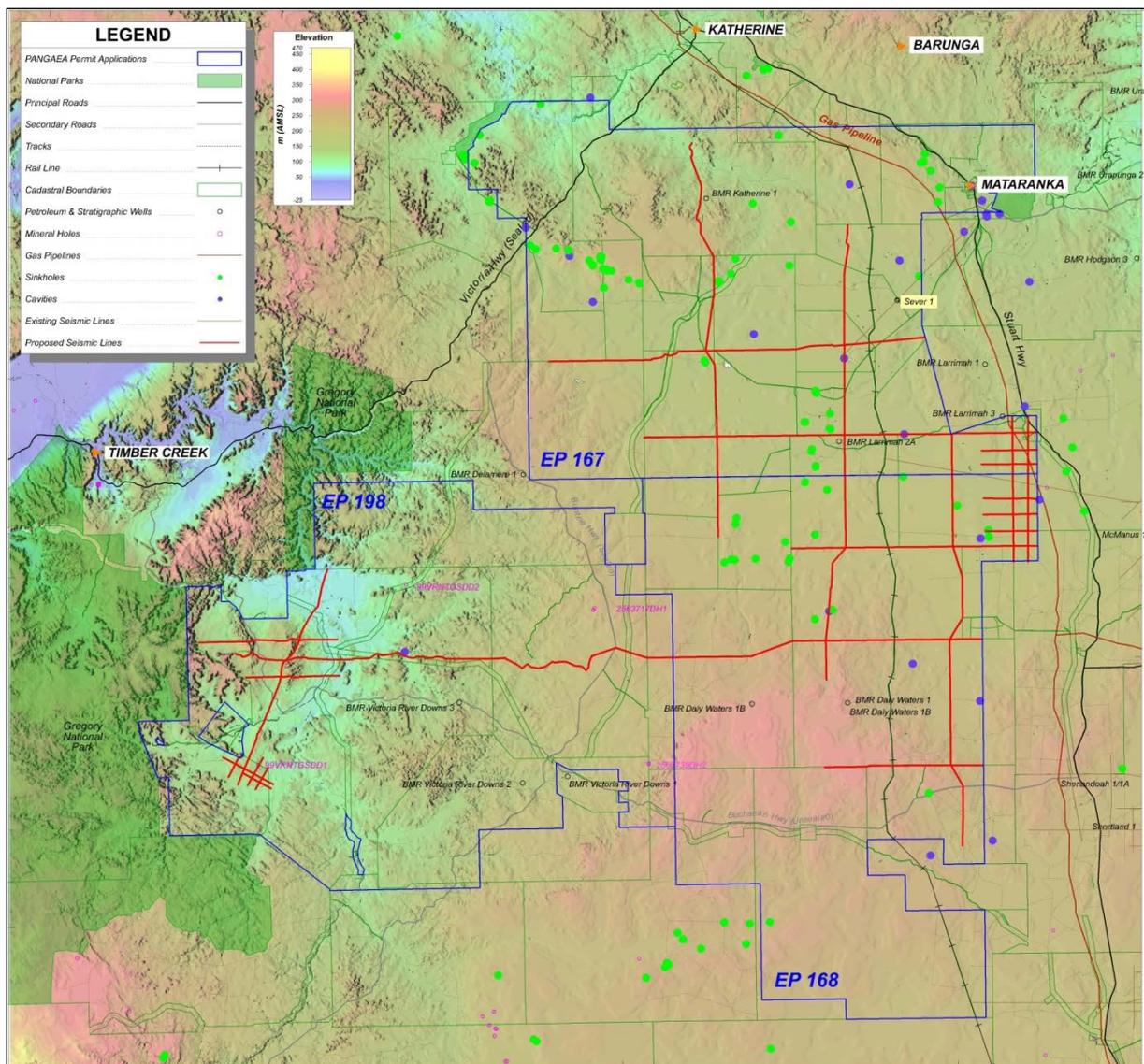


Figure 1: Location map showing 2D line layout with exploration permit boundaries

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

4. DESCRIPTION OF THE RECEIVING ENVIRONMENT

The activities are proposed within both the Sturt Plateau and Ord Victoria Plain bioregions. The Sturt Plateau bioregion comprises 99,719 km² and falls solely within the Northern Territory whilst the Ord Victoria Plain bioregion is found in northern Western Australia (WA) and the NT and includes ridges, plateaus and undulating plains, with scattered mesas and buttes over some 125,410 km².

Overall condition varies substantially across the tenements with many riparian areas and valley floors highly degraded by high stocking levels and high densities of feral animals (especially donkeys). To some extent, this degradation has been checked and, in some cases, reversed, by stock ex-closure, control of feral animals and more sustainable pastoral practices. However, there remain major problems with weeds, feral animals and changed fire regimes, and pastoralism probably continues to modify most lowland environments in the survey zone.

The average rainfall for the Sturt Plateau is 640 mm, although annual falls fluctuate between 500 mm and 800 mm. Nearly all the rainfall occurs in the months between November and March. There is a gradual shift in the relative abundance of particular vegetation species from the north (EP-167) to south and west (EP-168 & EP-198) such that the latter regions are dominated by a different suite of species to that of the north.

Upper stratum are often dominated by Eucalyptus and on clay soils. Acacia woodlands, dominated primarily by *Acacia shirleyi* (lancewood), are by far the most extensive plant communities throughout the tenements, followed by eucalypt savannah woodlands which typically have a sparse canopy, a dense tall grass understorey supporting seed-eating birds and exposure to frequent fire.

Black soil (largely basalt) plains interspersed throughout all tenements support a variety of perennial tussock grasses including Mitchell grass (*Astrebla* spp.), while on calcareous soils, Limestone grass (*Enneapogon* spp.) is prevalent. The major watercourses are normally lined with tall gum trees (*E. camaldulensis* and other eucalypts) and paperbarks (*Melaleuca* spp.).

5. DESCRIPTION OF THE ACTIVITY IN RELATION TO THE ENVIRONMENT

It is proposed to undertake a staged program of 2D seismic reflection profiling to image the upper 3 to 4 km of the subsurface.

The seismic program intends to minimise impacts on the environment by utilising existing roads, tracks and previously cleared fence lines wherever possible with 70% of line preparation along

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

existing roads, tracks and fence-lines. The remaining 30% of line preparation will require survey, ranging and machinery development to a track width of no more than 5 metres.

5.1 Line Preparation

Line preparation may include ‘stick raking’ and vegetation management for technical, safety and visibility reasons. Stick raking displaces logs and large sticks from the chosen alignment that could create a hazard or barrier. It is also likely that light grading may be used to smooth over very rough surfaces to make the alignment trafficable for the vibrator trucks and support 4WD vehicles.

Bull-dozers may also be employed in areas where the terrain is especially rough and inaccessible by grader or front end loader. Tree clearing is to be minimised by winding the alignments through heavily wooded areas and savannah woodlands around trees (>200mm diameter at breast height), however some tree losses and trimming is to be expected.

Where the alignments cross creeks, watercourses and depressions in the landscape, survey crews will attempt to utilise naturally cleared crossings (in the immediate area) before the final alignments are chosen in the field.

5.2 Self-Contained Camp

Pangaea’s primary service provider, Geokinetics, will manage a fully self-contained, mobile camp and consideration will be made to establish camps on fence line junctures, stock camps (away from the water source) or outstation establishments to maximize use of previously disturbed areas.

The camp consists of kitchen and diner units, showers, laundry units, generators, berth sleeper vans, mobile office support units for management and HSE, toilets, diesel tankers, mobile workshops, cold stores units, water bladders, communications units including internet and satellite phones, service trucks and transportation vehicles including low loaders and forklifts.

5.3 Acquisition activity

Geokinetics Australia will be the data acquisition contractor, and will be recording data utilizing the Sercel 428 / 408 acquisition system with up to 500 channels live spread. Sensors will be the I/O Sensor SM24 geophone. The energy source shall be the I/O AHVIV 60,000lb Vibroseis units.

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

Sercel 428 / 408 Acquisition System

The Sercel 428 / 408 acquisition system provides significant efficiency improvements over other acquisition systems where high channel count and technically difficult scenarios present themselves. The system allows great flexibility in obstacle avoidance, and provides proven reliability in harsh environments. The light weight nature of the field equipment and power consumption efficiency makes the system extremely versatile.



Figure 2: Sercel 428 / 408 Components (FDU, LAUL, LAUX)

Geophones (SM-24 Sensors)

SM-24 geophones in strings of six housed in land cases will be used. Sufficient quantities of geophones will be provided to ensure optimum production with enough spares to ensure adequate replacements are on the crew for scheduled maintenance.

The SM-24 geophone element is designed to offer a high performance in seismic exploration based upon I/O Sensor technology. The extended bandwidth allows a full potential of 2-ms / 24-bit recording systems. Geokinetics has a substantial inventory of geophone strings in various configurations available in country.

I/O AHV-IV 60,000lb Seismic Vibrator

The vibrators are equipped with dual frequency GPS/Glonass receivers utilizing Omnistar (HP/XP/G2) differential corrections to achieve decimeter level real time accuracy. Sercel vibe electronics are utilized allowing full acquisition technique flexibility. The units are fully capable of operating in stake-less mode for maximum efficiency where circumstances permit.

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**



Figure 3: AHV-IV Vibrator onsite in Australia

6. ENVIRONMENTAL MANAGEMENT APPROACH

Pangaea is committed to undertaking its exploration activities in a manner that minimizes the impact on the environment. The seismic survey is seen as an integral component of the exploration program to provide additional information required for the resource assessment, and a method to reduce the exploration impact.

A Geographic Information System (GIS) desktop analysis was performed specifically to focus on the locations of proposed camp sites and placement of seismic lines to collect the majority of the seismic data along already cleared paths – namely existing fence lines, tracks and roads. Upon development of a final alignment, the desk-top process continued considering the placement of seismic lines in relation to:

- Important vegetation communities (important habitat zones);
- Riparian areas;
- Sensitive soil landscapes;
- Known karst/cave systems and sinkholes; and
- Threatened or endangered fauna and flora data

The alignments were re-assessed, altered to account for the above assessment results and the alignments were inspected in the field as part of the Cultural Site Clearance process, led by the Northern Land Council. Field inspection was used to:

- Ground-truth the accuracy of the alignments;
- Identify any further socio-economic impacts that the proposed program may have on the community;
- Ensure nil impact on important cultural sites and/or landscapes; and

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

- Collect and collate further data on soils and vegetation types that may warrant redesign (i.e. interpretation of local knowledge of environmental conditions and sensitivities that the course level GIS data did not account for).

Hazard / Risk Assessment Process and Control Measures

Using this field data, each environmental hazard attributable to the proposed activities were identified and evaluated and the class of risk and likelihood ratings assigned using the table below. This hazard/risk assessment and management process is in line with industry best practices.

The risk ratings and likelihood of occurrence for all identified hazards have been developed in consultation with key personnel using industry knowledge that spans all sectors of petroleum exploration expertise, coupled with the desk-top summaries of the receiving environment. Personnel involved include those carrying out the activities themselves.

All hazards with a risk rating equal to or higher than ‘medium’ have had specific Environmental Management Measures developed and in sum all risks have been managed to ensure final risk exposure meets EMP requirements.

			0	1	2	3	4	5
			Remote	Highly Unlikely	Unlikely	Possible	Quite Likely	Likely
ACTUAL / POTENTIAL CONSEQUENCE SEVERITY	A+	Catastrophic	0A+	1A+	2A+	3A+	4A+	5A+
	A	Massive	0A	1A	2A	3A	4A	5A
	B	Major	0B	1B	2B	3B	4B	5B
	C	Moderate	0C	1C	2C	3C	4C	5C
	D	Minor	0D	1D	2D	3D	4D	5D
	E	Slight	0E	1E	2E	3E	4E	5E

LOW	MEDIUM	HIGH	SEVERE
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**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

Summary of Environmental Hazards & Controls for risks medium or higher

HAZARD	TREATMENT
	Management Actions to Ensure Final Risk Exposure meets EMP Requirements
Impacts on Flora and Fauna	<ul style="list-style-type: none"> As part of job-site induction prior to arrival on-site, awareness of ecological related issues will be provided for relevant staff. The potential impacts on threatened species, populations, ecological communities and their habitats, and critical habitat will be assessed across each tenement. Access tracks will be located in areas that will result in minimal ground disturbance and impact on threatened flora or fauna, or endangered ecological communities. Line preparation through vegetated areas (off existing tracks and fence lines) is to be conducted with a regular straight blade or a stick rake and will not be wider than approximately 5 meters. Where existing tracks and fence lines require regrowth clearing to facilitate access, a stick rake or grader will be used to clear access not wider than 7m. Logs, branches and cleared grass filled dirt windrows will be avoided where possible and minimised at all other times.
Air Quality (Dust)	<ul style="list-style-type: none"> Speed limits on access tracks and seismic lines, required to the limit and minimise dust generation will be clearly communicated to crews. Appropriately inform affected pastoralists as specified in the access agreement and providing updated information as required. Seismic survey will not be undertaken outside of the specified alignments. Seismic survey will not be undertaken within designated road reserves. Where practical, all vehicular movements to and from the seismic recording site would be made only during daylight hours and/or compliant with land access agreement. Individual vehicular trips to and from the site will be kept to a minimum.
Fuel & Chemical Spills	<ul style="list-style-type: none"> Fuels, lubricants and chemicals shall be stored and handled within containment areas (such as portable bunding, or self bunded). Refuelling is to be undertaken within the designated refuelling sites or on flat and stable ground and not within 25m of a watercourse or other riparian area. The amount of hazardous material stored and used on site shall be kept to a minimum.
Introduction of Noxious Weeds	<ul style="list-style-type: none"> Machinery and vehicles will be certified ‘weed free’ by a registered agent before arriving in the tenement to begin works and before leaving the NT post the exploration program. Areas of known environmental weeds, noxious weeds or problem plants as defined in this EMP will be avoided by line preparation crews wherever practical. Seismic line field crews will undertake a visual check of seed in clothes and protective gear daily. Clean-down points may be established at entry \ exit points of the railway right of way \ fence line. All clean-down areas to be clearly sign-posted and GPS points recorded.

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

	<ul style="list-style-type: none"> • Each time a vehicle passes a clean-down point, a visual inspection of the under body and tyres/tracks of the vehicle will be performed. • A dedicated weed management vehicle equipped with an air compressor, will be on site to clean vehicles or equipment when necessary, particularly those most likely to pick up or transport weed material (bulldozers, survey and rehab vehicles).
<p style="color: red;">Impact on Cultural Heritage Values or Sacred Sites</p>	<ul style="list-style-type: none"> • In the event that a site of potential significance is identified in the field, the seismic alignment will be altered to avoid impacts on the site. • In the event that the seismic alignment cannot be altered to avoid the site or artefact. • Work will cease in the area of the discovery AND the person discovering the site or artefact will notify their supervisor who will ensure that work has ceased and the area(s) is (are) cordoned off with tape. • Work will not recommence in the area of any discovery until the site or artefact has been inspected and the requirements of the Department have been met.
<p style="color: red;">Bushfire</p>	<ul style="list-style-type: none"> • Bushfires NT will be notified of the exploration strategy and operational plans will be provided for comment. • A minimum of one 400lt slip-on unit will be onsite with the line preparation team at all times. Works are not to commence or continue until the slip-on unit is onsite and in working order. • Fire control water pumps and hoses are to be readily accessible, on site and well maintained. • All personnel will be provided fire retardant clothing and fire fighting equipment as required ensuring the safety of persons and property. • All items of plant used during proclaimed high fire danger periods that could discharge sparks must be fitted with spark arresters. • No onsite cutting, welding, grinding or other activities likely to generate fires in the open on days when a total fire ban is proclaimed. • Before work such as welding, thermal or oxygen cutting, heating or other fire/spark producing operations are started; the area of the works will be thoroughly wet down using the slip on units. • During data capture, all crews will have an additional water fire extinguisher, shovel, rake and fire beater as standard vehicle equipment to let the driver be a relevant first responder. • Camp sites must have a suitable area cleared around the perimeter to allow for a bush fire to burn through the area and not damage the camp. • Car parks and refuelling areas must all be at least 20m from the bush perimeter so as not to be a risk if an uncontrolled bush fire burns through the area.
<p style="color: red;">Soil Erosion</p>	<ul style="list-style-type: none"> • Speed limits on access tracks and seismic lines to the limit and minimise dust generation, will be clearly communicated to crews. • Seismic survey will not be undertaken outside of the specified alignments. • Minimise and prevent long-term scarring by limiting the creation of windrows at all times. • Operate the grader or bladed loader with the blade, bucket or stick rake raised wherever practical. • Avoid windrow development in drainage lines so as to not cause any disruptions in natural drainage.

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

	<ul style="list-style-type: none">• In dissected tablelands deviate around escarpments and steep terrain.• Minimise disturbance to creek and river banks and any naturally formed depressions.• Vehicles to deviate around creeks, rivers and naturally formed depressions to avoid leaving wheel ruts to eliminate a visual corridor effect.• Cross creeks in a naturally clear area.• Individual vehicular trips to and from the site will be kept to a minimum.• Where required, investigate the use of a mobile vegetation chipper to cover seismic lines with mulch post data capture. Where a chipper is not feasible or warranted, use cleared vegetation to cover bare soil, promote regeneration, reduce erosion and prevent further vehicle access.• On existing fence lines and tracks, restoration will involve filling and compaction of deep wheel ruts \ bulldust pits and removal of any windrows.• Where required, ‘whoa-boys’ will be installed in strategic locations to stop or slow water flow along long sections of straight alignment within erosive soil landscapes as identified by the EMR.• If roads are wet to the point that vehicle traffic will cause wheel rut damage then all operations are to stop. Any “damage” to a road by seismic vehicles under these circumstances is to be filled and compacted as soon as practical to do so.
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Rehabilitation

Once the program has been completed, all pegs used to mark the line will be collected and equipment removed. The focus for the rehabilitation strategy is:

- Repair and restore wheel ruts or obvious signs of vehicle caused disturbance;
- Establish a protection over areas of bare soil to prevent erosion. This can be achieved through various methods and an appropriate strategy will be developed for each line that considers the soil structure, soil landscape and ecological communities through which it has passed. For example, highly erosive soils may require more rehabilitation effort (engineering solutions like ‘whoa-boys’) than those on relatively stable, deeply mulched soil profiles (re-establishment of sticks, leaves and debris);
- Restrict access to the alignments to allow for natural regeneration. This is likely to span a full cycle of wet and dry season post the rehabilitation effort; and
- Periodically revisit the photo monitoring points (established prior to line preparation phase) to ensure regeneration is successful and where it is not, develop new strategies to ensure success over the longer term.

**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

7. CONSULTATION

Consultation has been undertaken with the following stakeholders regarding the exploration program and will continue during the operations:

Stakeholder	Communication and Consultation	Project Related Issues	Resolution
Pastoralists	Seismic Activity Notification Letter of interest to open communications and reach arrangements Phone/Email/Meetings	Increase in traffic, increase in road wear, water requirements, camp site locations, weed management, stock management, and fire prevention.	Access agreement. Presented information of all the seismic program and reached agreement on all issues.
Northern Land Council and TOs	Meetings: Darwin NLC, community meetings. Presentations/ field investigations Phone/Email	Concerns regarding damage to sacred sites and culturally significant landscapes.	Presented outline of exploration program and methods. Cultural survey completed with TOs and all alignments culturally cleared.
NT Government DME	Phone/Email/Meetings	Complete exploration program. EMP draft and associated issues.	Developed EMP and provided extensive support documentation. Prepared NOI for DoR.
NT Government DoH	Phone/Email/Meetings	Concerns regarding damage to archaeological sites and culturally significant landscapes.	Clearance after presenting the results of Archaeological Surveys.
NT Government DoT/DoI/RND	Phone/Email/Meetings	Use of road reserve for data acquisition on the Buchanan area	Permission to use road reserve utilizing a certified traffic manager plan designer.
Telstra (Fibre Cable)	Phone/Email	Fibre cable crossing for seismic data acquisition	Agreement with terms and conditions.
GWA Railway (Rail Tracks)	Phone/Email	Rail Tracks crossing for seismic data acquisition and use of road reserve to optimize efficiency during equipment move.	Deed of Release and Indemnity Agreement with terms and conditions. Inspector to approve operations after a physical demonstration. Safety worker to be present for operations close to the rail track

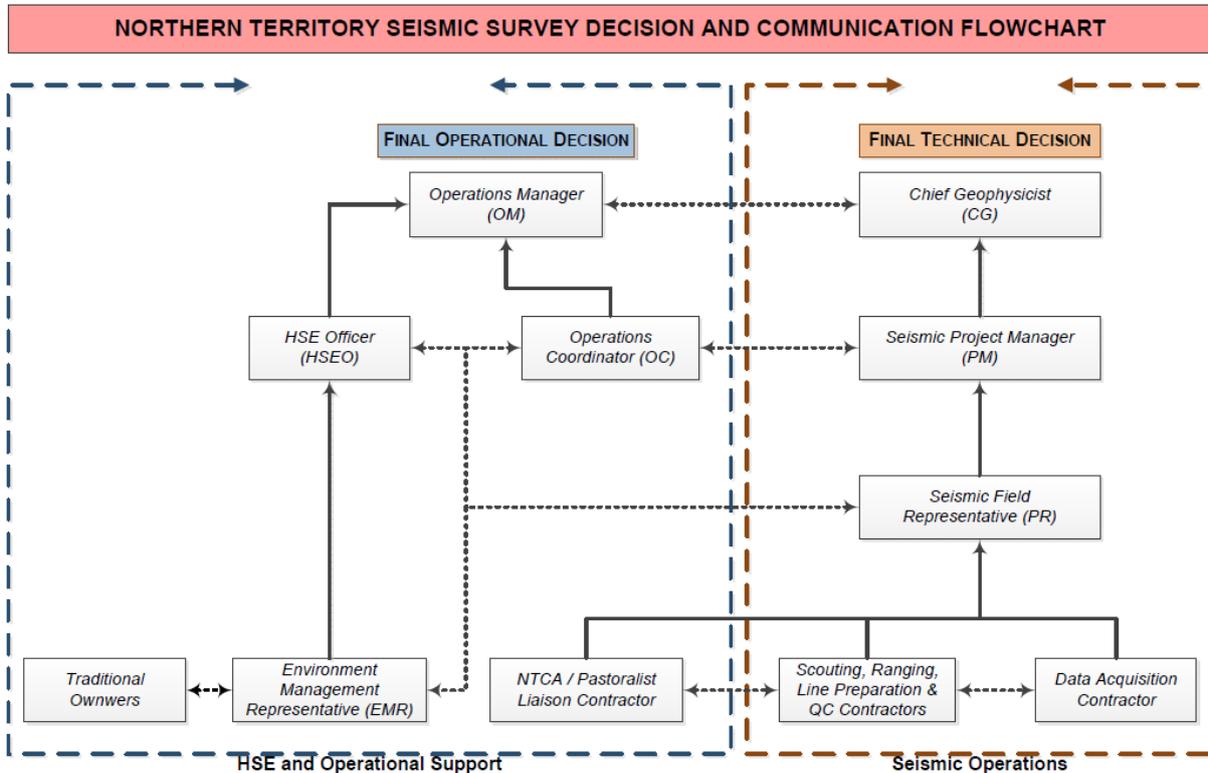
**“HIDDEN VALLEY” SEISMIC SURVEY
ENVIRONMENTAL PLAN SUMMARY**

Stakeholder	Communication and Consultation	Project Related Issues	Resolution
APA Group (Gas Pipeline)	Phone/Email	Gas pipeline crossing for seismic data acquisition	Third Party Works Authorization with terms and conditions granted
Other Stakeholders (Local Councils, Police, Local Businesses)	Phone/Email	General project information distribution. Provision of Emergency and Contractor Services for seismic operations.	Letters of Notification with description of the Seismic Program. Updates of operations progress.

8. NOMINATED LIAISON PERSONNEL

8.1 Seismic Survey Communiation Chart

The Hidden Valley Seismic Survey team will consist of the following lead roles:



8.2 Pangaea Resources Operations Liason Pesonnel

Sydney Office		
Seismic Project Manager	info@pangaea.net.au	Phone: (02) 9017 9600